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PCI Express Protocol Analysis
Summit Analyzer User Manual



For PCIe Protocol Analysis Version 13.30

Generated: March 16, 2026, 06:15 PM

Teledyne LeCroy Protocol Solutions Group

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WEEE Program



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Chapter 1

Introduction/Overview

1.0 Introduction

This chapter provides an overview of the following Summit Analyzers:

- Summit T3-16 PCI Express Protocol Analyzer
- Summit T3-8 PCI Express Protocol Analyzer
- Summit T34 PCI Express Protocol Analyzer
- Summit T28 PCI Express Protocol Analyzer
- Summit T24 PCI Express Protocol Analyzer

1.1 PCIe Protocol Analysis™

The Teledyne LeCroy Summit Analyzer family utilizes the PCIe Protocol Analysis to assist users in analyzing how PCI Express components work together, diagnose problems, and test for interoperability and standards compliance.

1.1.1 CATC Trace

PCIe Protocol Analysis uses CATC Trace, which is a powerful and intuitive serial protocol display embedding detailed knowledge of the protocol hierarchy and intricacies, as defined in the protocol specification. The software allows the user to control the Analyzer and set specific real-time triggering and filtering conditions. The PCIe Protocol Analysis utilizes a Windows-based graphical display that has been optimized for fast and easy navigation through a captured traffic session. Users are alerted as violations are detected at all levels of the protocol layering and can easily drill down on areas of interest or collapse and hide fields that are not relevant.

1.1.2 Software Features

PCIe Protocol Analysis is used to operate the Summit Analyzers T3-16, T3-8, T34, T28 and T24. Below table highlights some of the major features:

Features	Description
Powerful and Intuitive CATC Trace™ Analysis	Faster interpretation and debug of PCI Express traffic with color-coded, clearly labeled protocol elements in a graphical display. The CATC Trace embeds deep understanding of the PCI Express protocol hierarchy and intricacies. This knowledge is presented in a colorful, intuitive and easy-to-use graphical display, allowing you to quickly capture and validate PCI Express product designs.
Protocol Hierarchical Viewing	Displays Packet, Transaction, Split, NVMe, PQI, AHCI, ATA, SOP and SCSI command transactions levels of the PCI Express protocol, with increased drill-down detail for PCI Express primitives, errors, payloads or individual packets.
Extensive Decoding	Complete, accurate and reliable decoding of TLPs (Transaction Layer Packets), DLLPs (Data Link Layer Packets), NVMe, PQI, AHCI, ATA, SOP and SCSI command transactions and all PCI Express Primitives.
Intelligent Reporting	Quickly identify and track error rates and abnormal link or timing conditions. Display configuration space and protocol specification details.
Sophisticated Viewing	View Packet, Link, Split, NVMe, PQI, AHCI ATA, SOP and SCSI command transaction levels of the PCI Express protocol. Collapsible/expandable headers with Tool tip explanations make it easy to navigate and interpret packet contents, headers, and commands. View packets, transactions of TLPs and DLLPs in classic CATC Trace™ format or in raw bit stream for deeper analysis.
Downloadable CATC Trace Viewer	Share and annotate CATC Trace recordings within a development team. Freely distributable PCIe Protocol Analysis enables collaborative analysis across sites and time zones.
Dword to Transaction Level Viewer	View Dwords, Packet, Link, Split, NVMe, PQI, AHCI ATA, SOP and SCSI command transaction levels of the PCI Express protocol.
Lane-Reversal Compatible	Triggers, records, and displays PCI Express traffic logically, regardless of the physical configuration of the lanes.

Statistical and Error Reporting	Provides a quick summary of the CATC Trace file to identify and track error rates and abnormal link or timing conditions.
Bit Tracer Recording Mode (optional)	Records the bytes exactly as they come across the link, allowing debugging of PHY layer problems.
Auto Speed detection	Follows link transitions through speed changes.
Auto Calibration	Provides better signal recovery while recording traces.
Lane Swizzling Support	Allows board developers to lay out lanes in a non-standard order, simplifying board design.
CrossSync Application	The CrossSync application allows you to select analyzers for synchronization and manage the recording process.
Gen1/Gen2 Compliance Patterns	Decoding of Gen1/Gen2 Compliance Patterns is supported as well as Filtering them out of the traffic stream.

1.1.3 Other Documents

For more information, refer to the following documents:

- *Teledyne LeCroy Analyzers File-based Decoding Manual*
- PCIe Protocol Suite / Trainer Automation Manual
- PCIe Protocol Suite / VSE Manual
- CrossSync Control Panel User Manual

1.1.4 Host Machine Requirements

Each of the Summit Analyzers (T3-16, T3-8, T34, T28 and T24) connects to a host machine. Please consult the **Readme** file in the software installation for the latest host machine requirements or under **Start -> All Apps -> LeCroy -> PCIe Protocol Analysis -> Readme** for Windows 10 installations.

Note: Other versions of Windows may have slightly different paths to the **Readme** file.

1.2 Summit Analyzer Hardware

1.2.1 Summit T3-16 Analyzer Hardware

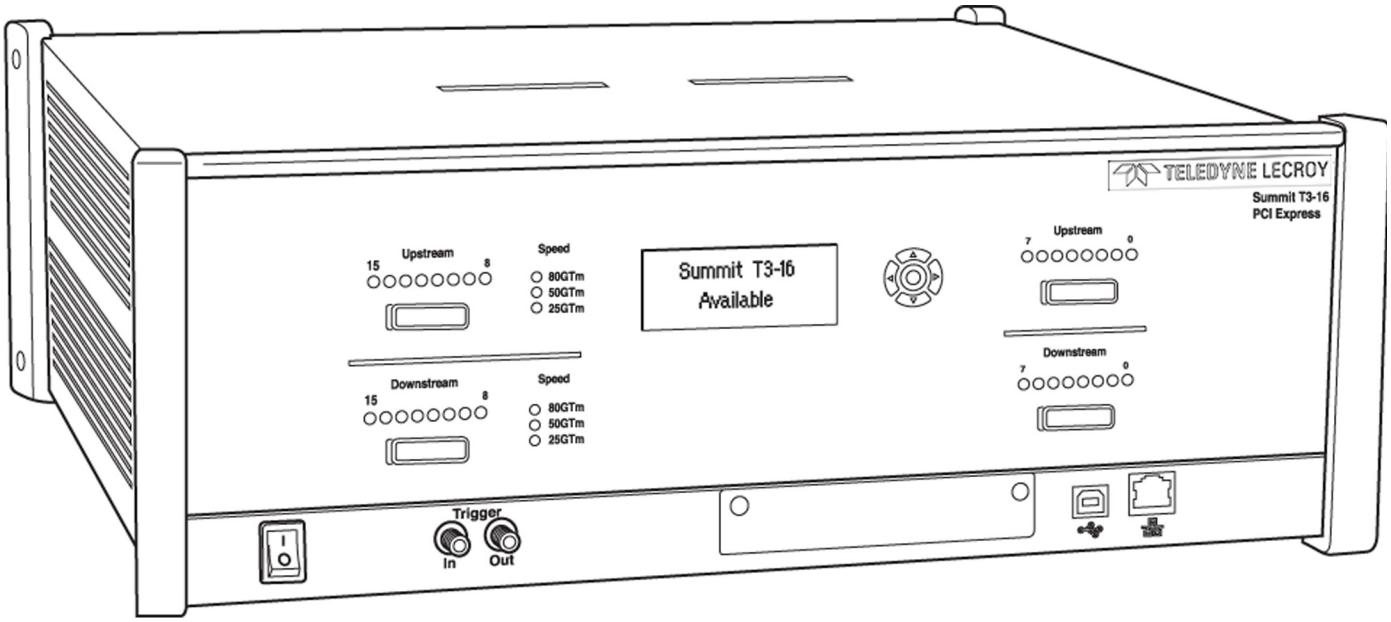


Figure 1.1: Summit T3-16 Analyzer

Summit T3-16 Analyzer Hardware Features:

Features	Description
Front Panel: LCD Display	Allows you to configure T3-16 and view status.
Front Panel: Navigation Buttons	Navigate through the LCD Display.
Front Panel: LEDs	LEDs for: Upstream traffic activity, Downstream traffic activity, Power, Speed
Front Panel: Data Connectors	Upstream[15:8] and [7:0], Downstream[15:8] and [7:0]
Front Panel: Trigger In, Trigger Out	Provides for External Trigger capability.
Front Panel: Flexible Host Interface:	
GIGE Ethernet Connectivity	Allows connection to an Ethernet network and sharing of analyzer resources by multiple engineers.
USB connectivity	Allows connection by USB cable.

Front Panel: Expansion Slot	For CATC Sync Expansion Card
Front Panel: AC Power Switch	1 = On, 0 = Off
8 GB Recording Capacity, 4 GB in each direction	Capture long recording sessions for analysis and problem solving.
Bidirectional x1-x16, 2.5 GBps to 8.0 GBps recording support	Accurate and non-intrusive collection of PCI Express CATC Trace data.
Flexible probing options	Supports variety of probing options including slot interposers, MidBus probes and specialty probes. Gen3 interposer Gen3 MidBus probe Gen2 MidBus probe Gen2 multi-lead probe Gen2 active and passive interposers
Field-upgradeable firmware and recording engine	Positions you to receive the latest PCIe Protocol Analysis enhancements and future additional capabilities. Allows field upgrades of all system types. Upgrades available for download direct from the Teledyne LeCroy website.
Rear Panel	AC Power Connector, Enclosed 5.0 A 250 V fuse

1.2.2 Summit T3-8 Analyzer Hardware

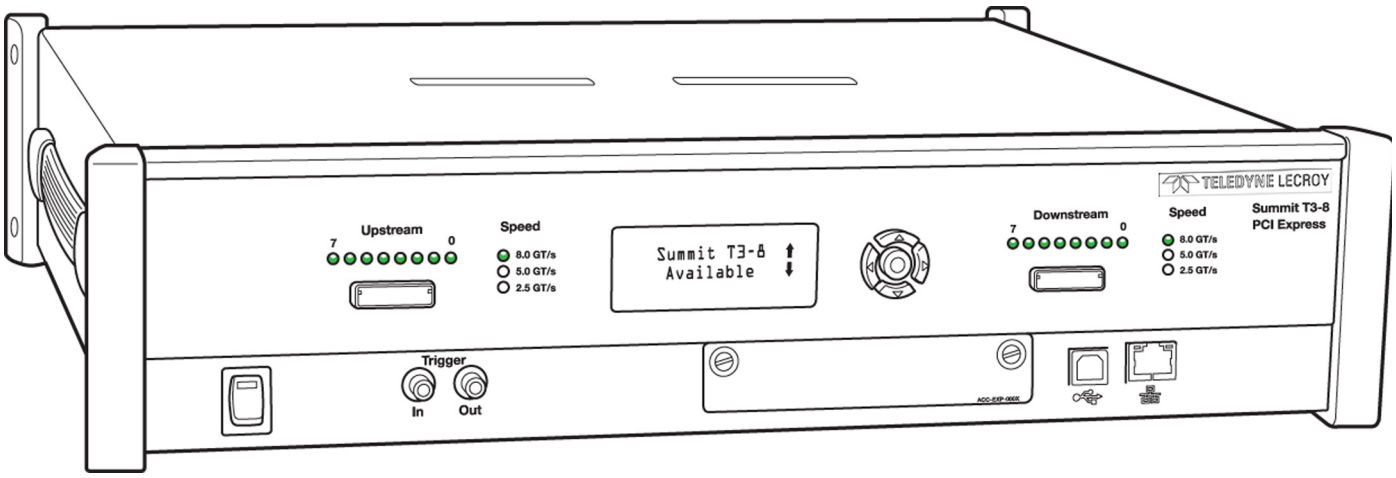


Figure 1.2: Summit T3-8 Analyzer

Summit T3-8 Analyzer Hardware Features:

Features	Description
Front Panel: LCD Display	Allows you to configure T3-8 and view status.
Front Panel: Navigation Buttons	Navigate through the LCD Display.
Front Panel: LEDs	LEDs for: Upstream traffic activity, Downstream traffic activity, Power, Speed
Front Panel: Data Connectors	Upstream[7:0], Downstream[7:0]
Front Panel: Trigger In, Trigger Out	Provides for External Trigger capability.
Front Panel: Flexible Host Interface: GIGE Ethernet Connectivity USB connectivity	 Allows connection to an Ethernet network and sharing of analyzer resources by multiple engineers. Allows connection by USB cable.
Front Panel: Expansion Slot	For CATC Sync Expansion Card
Front Panel: AC Power Switch	1 = On, 0 = Off
4 GB Recording Capacity, 2 GB in each direction	Capture long recording sessions for analysis and problem solving.
Bidirectional x1-x8, 2.5 GBps to 8.0 GBps recording support	Accurate and non-intrusive collection of PCI Express CATC Trace data.

Flexible probing options	Supports variety of probing options including slot interposers, MidBus probes and specialty probes. Gen3 interposer Gen3 MidBus probe Gen2 MidBus probe Gen2 multi-lead probe Gen2 active and passive interposers
Field-upgradeable firmware and recording engine	Positions you to receive the latest PCIe Protocol Analysis enhancements and future additional capabilities. Allows field upgrades of all system types. Upgrades available for download direct from the Teledyne LeCroy website.
Rear Panel	AC Power Connector, Enclosed 5.0 A, 250 V fuse

1.2.3 Summit T34 Analyzer Hardware

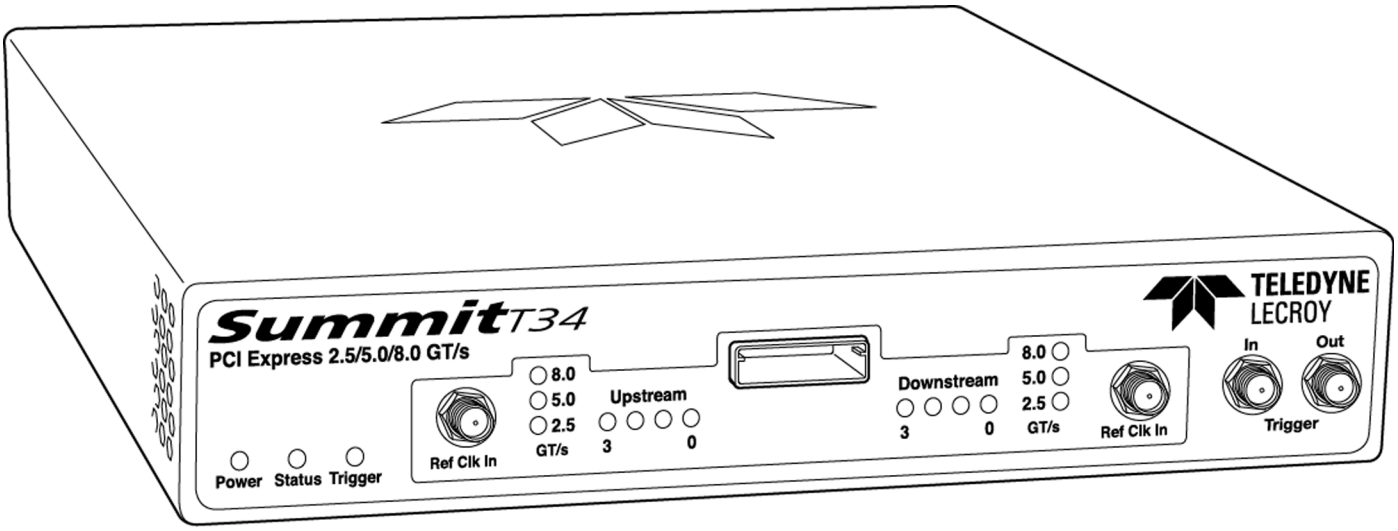


Figure 1.3: Summit T34 Analyzer

Summit T34 Analyzer Hardware Features:

Features	Description
Front Panel: LEDs	LEDs for: Power, Status, Trigger, Speed, Upstream traffic activity, Downstream traffic activity
Front Panel: Trigger In, Trigger Out	Provides for External Trigger capability.
Front Panel: Ref Clk	Provides an optional connection for an external reference clock (Upstream and Downstream).
Front Panel: Data Connector	Upstream[3:0], Downstream[3:0]
32 GB Recording Capacity, 16 GB in each direction 16 GB Recording Capacity, 8 GB in each direction 8 GB Recording Capacity, 4 GB in each direction	Capture long recording sessions for analysis and problem solving.
Bidirectional x1-x4 2.5 GBps to 8.0 GBps recording support	Accurate and non-intrusive collection of PCI Express CATC Trace data.

Flexible probing options	Supports variety of probing options including slot interposers, MidBus probes and specialty probes. Gen3 interposer Gen3 MidBus probe Gen2 MidBus probe Gen2 multi-lead probe Gen2 active and passive interposers
Field-upgradeable firmware and recording engine	Positions you to receive the latest PCIe Protocol Analysis enhancements and future additional capabilities. Allows field upgrades of all system types. Upgrades available for download direct from the Teledyne LeCroy website.
Rear Panel: Flexible Host Interface:	
GIGE Ethernet Connectivity	Allows connection to an Ethernet network and sharing of analyzer resources by multiple engineers.
USB connectivity	Allows connection by USB cable.
Rear Panel: x8 Expansion	Used to connect two Summit T34 analyzers
Rear Panel: Sync/Data	Synchronization connectors to enables cross triggering between other test instruments.
Rear Panel: Power Switch	1 = On, 0 = Off
Rear Panel: DC In	12V, 7A

1.2.4 Summit T28 Analyzer Hardware

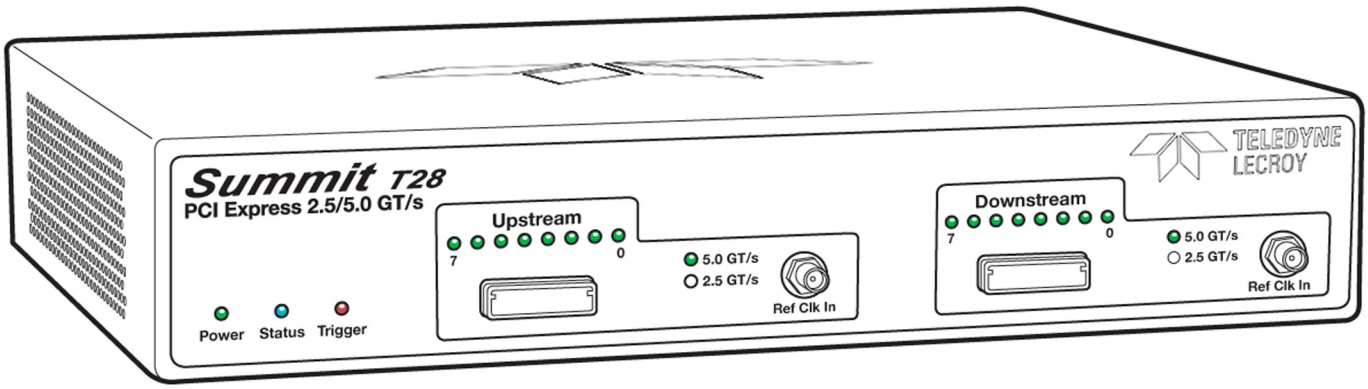


Figure 1.4: Summit T28 Analyzer

Summit T28 Analyzer Hardware Features:

Features	Description
Front Panel: LEDs	LEDs for: Power, Status, Trigger, Speed, Upstream traffic activity, Downstream traffic activity
Front Panel: Ref Clk	Provides an optional connection for an external reference clock (Upstream and Downstream).
Front Panel: Data Connectors	Upstream[7:0], Downstream[7:0]
2 GB Recording Capacity, 1 GB in each direction	Capture long recording sessions for analysis and problem solving.
Bidirectional x1-x8, 2.5 GBps to 5.0 GBps recording support	Accurate and non-intrusive collection of PCI Express CATC Trace data.
Flexible probing options	Supports variety of probing options including slot interposers, MidBus probes and specialty probes. Gen2 MidBus probe Gen2 multi-lead probe Gen2 active and passive interposers
Field-upgradeable firmware and recording engine	Positions you to receive the latest PCIe Protocol Analysis enhancements and future additional capabilities. Allows field upgrades of all system types. Upgrades available for download direct from the Teledyne LeCroy website.

Rear Panel: Flexible Host Interface:	
GIGE Ethernet Connectivity	Allows connection to an Ethernet network and sharing of analyzer resources by multiple engineers.
USB connectivity	Allows connection by USB cable.
Rear Panel: Trigger In / Trigger Out	Provides external trigger capability.
Rear Panel: Sync In / Sync Out	Synchronization connectors to enables cross triggering between other test instruments.
Rear Panel: Power Switch	1 = On, 0 = Off
Rear Panel: DC In	12V, 5A

1.2.5 Summit T24 Analyzer Hardware

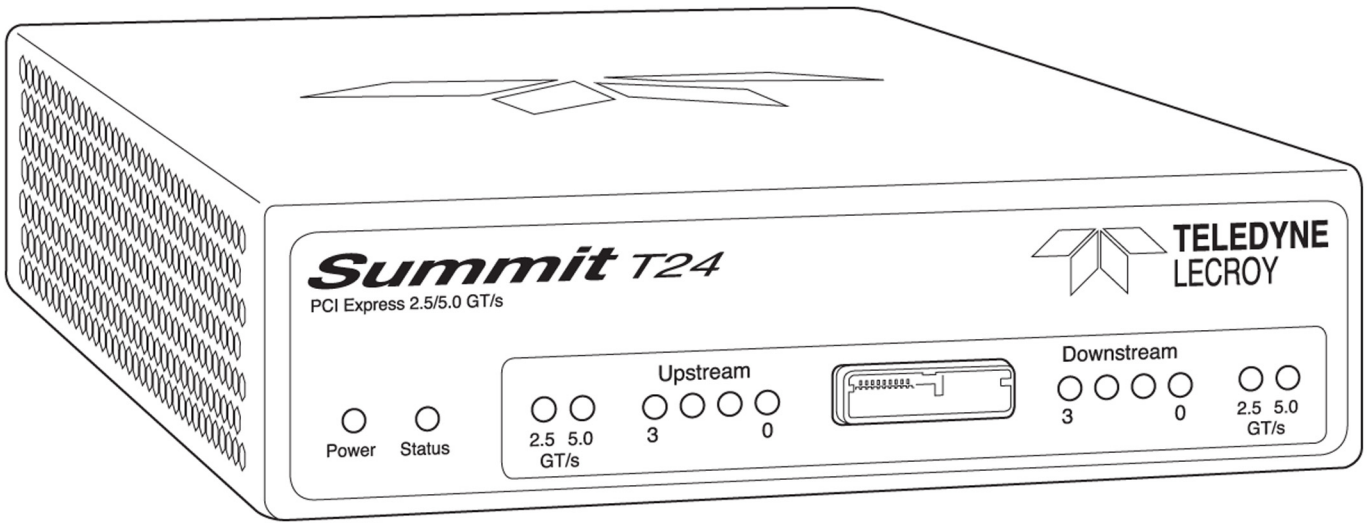


Figure 1.5: Summit T24 Analyzer

Summit T24 Analyzer Hardware Features:

Features	Description
Front Panel: LEDs	LEDs for: Power, Status, Speed, Upstream traffic activity, Downstream traffic activity
Front Panel: Data Connector	Upstream[3:0], Downstream[3:0]
2 GB Recording Capacity, 1 GB in each direction	Capture long recording sessions for analysis and problem solving.
Bidirectional x1-x4, 2.5 GBps to 5.0 GBps recording support	Accurate and non-intrusive collection of PCI Express CATC Trace data.
Flexible probing options	Supports variety of probing options including slot interposers, MidBus probes and specialty probes. Gen2 MidBus probe Gen2 multi-lead probe Gen2 active and passive interposers
Field-upgradeable firmware and recording engine	Positions you to receive the latest PCIe Protocol Analysis enhancements and future additional capabilities. Allows field upgrades of all system types. Upgrades available for download direct from the Teledyne LeCroy website.

Rear Panel: Flexible Host Interface:	
GIGE Ethernet Connectivity	Allows connection to an Ethernet network and sharing of analyzer resources by multiple engineers.
USB connectivity	Allows connection by USB cable.
Rear Panel: Sync/Data	Synchronization connectors to enables cross triggering between other test instruments.
Rear Panel: Power Switch	1 = On, 0 = Off
Rear Panel: DC In	12V, 3A

1.3 Environmental Conditions

- Temperature: Operating 32° F to 122° F (0° C to 50° C)
- Temperature: Non-Operating 14° F to 176° F (-10° C to 80° C)
- Humidity: Operating 10% to 90% RH (non-condensing)

1.4 Summit T3-16 PCI Express Protocol Analyzer Overview

Designed for developers and validators, the Teledyne LeCroy Summit T3-16™ is a Gen1/Gen2/ Gen3 PCI Express advanced verification system.

By leveraging years of experience in protocol analysis tools for emerging markets, Summit T3-16 blends sophisticated functionality with practical features to speed the development of PCI Express™ IP cores, semiconductors, bridges, switches, add-in boards, and systems.

The Teledyne LeCroy Summit T3-16 is Teledyne LeCroy's high performance PCI Express analyzer for customers in server, workstation, desktop, graphics, storage and network card markets.

1.4.1 Summit T3-16 Analyzer

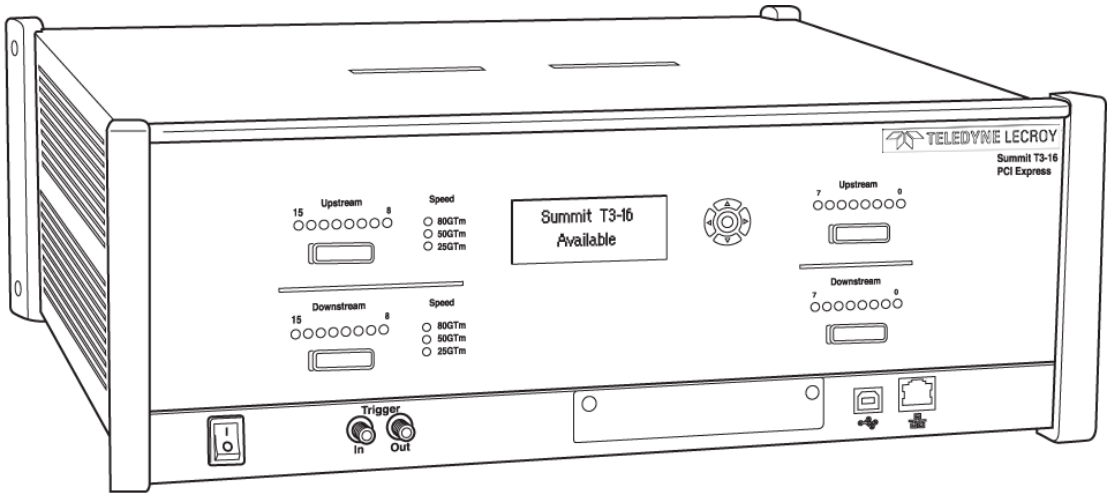


Figure 1.6: Summit T3-16 Analyzer

With advanced features such as support for PCI Express Spec 3.0, data rates from 2.5 to 8.0 GBps, link widths from x1 to x16, and a full 8 GB of memory, the Summit T3-16 provides unmatched capability and flexibility for developers and users of advanced PCI Express products. The Summit T3-16 is the most advanced and sophisticated PCI Express Analyzer available in the market today.

As with other Teledyne LeCroy PCI Express analyzers, the Summit T3-16 leverages the intuitive and powerful CATC Trace analysis system, embedding a deep understanding of the PCI Express protocol hierarchy and intricacies. The colorful, intuitive and easy-to-use graphical display allows you to quickly capture and validate PCI Express product designs.

In addition to a full suite of advanced hardware and software features, the Summit T3-16 has user-convenience and analysis features, such as support for "lane swizzling," which allows a board developer to lay out a mid-bus probe pad with lanes in non-standard order, simplifying the design of the board. Internally, the Summit T3-16 maps the lanes back into their correct order and accurately displays the embedded bus traffic. An optional Bit Tracer mode allows bytes to be recorded as they come across the link, allowing debugging of PHY layer problems and combining the features of a logic analyzer format with a protocol analyzer format.

The Summit T3-16 supports USB and GIGE host interfaces. By connecting over GIGE, engineers can operate the system remotely (for example, install the client software on their desktop systems to control an analyzer operating in a remote lab). Also, multiple engineers working collaboratively can time-share use of a single analyzer, reducing the need for an additional analyzer for each engineer and increasing the cost effectiveness of the product.

1.5 Summit T3-8 PCI Express Protocol Analyzer Overview

Designed for developers and validators, the Teledyne LeCroy Summit T3-8™ is a Gen1/Gen2/Gen3 PCI Express™ advanced verification system.

By leveraging years of experience in protocol analysis tools for emerging markets, Summit T3-8 blends sophisticated functionality with practical features to speed the development of PCI Express IP cores, semiconductors, bridges, switches, add-in boards, and systems.

The Teledyne LeCroy Summit T3-8 is Teledyne LeCroy's high performance PCI Express analyzer for customers in server, workstation, desktop, graphics, storage and network card markets.

1.5.1 Summit T3-8 Analyzer

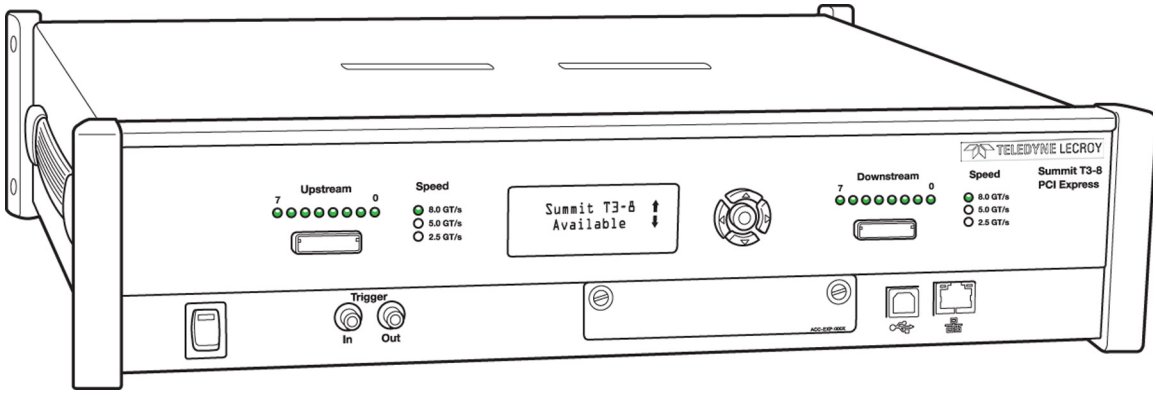


Figure 1.7: Summit T3-8 Analyzer

With advanced features such as support for PCI Express Spec 3.0, data rates from 2.5 to 8.0 GBps, link widths from x1 to x8, and 4 GB of memory, the Summit T3-8 provides unmatched capability and flexibility for developers and users of advanced PCI Express products. The Summit T3-8 is the most advanced and sophisticated PCI Express Analyzer available in the market today.

As with other Teledyne LeCroy PCI Express analyzers, the Summit T3-8 leverages the intuitive and powerful CATC Trace analysis system, embedding a deep understanding of the PCI Express protocol hierarchy and intricacies. The colorful, intuitive and easy-to-use graphical display allows you to quickly capture and validate PCI Express product designs.

In addition to a full suite of advanced hardware and software features, the Summit T3-8 has user-convenience and analysis features, such as support for automatic "lane swizzling," which allows a board developer to lay out a mid-bus probe pad with lanes in non-standard order, simplifying the design of the board. Internally, the Summit T3-8 maps the lanes back into their correct order and accurately displays the embedded bus traffic. An optional BitTracer™ mode allows bytes to be

recorded as they come across the link, allowing debugging of PHY layer problems and combining the features of a logic analyzer format with a protocol analyzer format.

The Summit T3-8 supports USB and GIGE host interfaces. By connecting over GIGE, engineers can operate the system remotely (for example, install the client software on their desktop systems to control an analyzer operating in a remote lab). Also, multiple engineers working collaboratively can time-share use of a single analyzer, reducing the need for an additional analyzer for each engineer and increasing the cost effectiveness of the product.

1.6 Summit T34 PCI Express Protocol Analyzer Overview

Designed for developers and validators, the Teledyne LeCroy Summit T34™ is a Gen1/Gen2/Gen3 PCI Express™ advanced verification system.

By leveraging years of experience in protocol analysis tools for emerging markets Summit T34 blends sophisticated functionality with practical features to speed the development of PCI Express IP cores, semiconductors, bridges, switches, add-in boards, and systems.

The Teledyne LeCroy Summit T34 is Teledyne LeCroy's high performance PCI Express analyzer for customers in server, workstation, desktop, graphics, storage and network card markets.

1.6.1 Summit T34 Analyzer

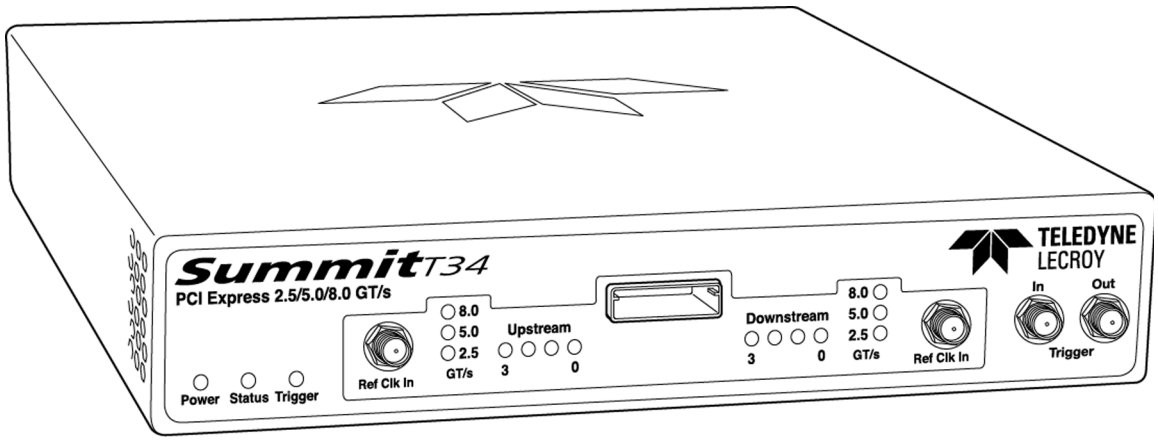


Figure 1.8: Summit T34 Analyzer

With advanced features such as support for PCI Express Spec 3.0, data rates from 2.5 up to 8.0 GBps, link widths from x1 up to x4, and up to 16 GB of memory, the Summit T3-8 provides unmatched capability and flexibility for developers and users of advanced PCI Express products. The Summit T34 is the most advanced and sophisticated PCI Express Analyzer available in the market today.

As with other Teledyne LeCroy PCI Express analyzers, the Summit T34 leverages the intuitive and powerful CATC Trace analysis system, embedding a deep understanding of the PCI Express protocol hierarchy and intricacies. The colorful, intuitive and easy-to-use graphical display allows you to quickly capture and validate PCI Express product designs.

In addition to a full suite of advanced hardware and software features, the Summit T3-8 has user-convenience and analysis features, such as support for automatic "lane swizzling," which allows a

board developer to lay out a mid-bus probe pad with lanes in non-standard order, simplifying the design of the board. Internally, the Summit T34 maps the lanes back into their correct order and accurately displays the embedded bus traffic. An optional BitTracer™ mode allows bytes to be recorded as they come across the link, allowing debugging of PHY layer problems and combining the features of a logic analyzer format with a protocol analyzer format.

The Summit T34 supports USB and GIGE host interfaces. By connecting over GIGE, engineers can operate the system remotely (for example, install the client software on their desktop systems to control an analyzer operating in a remote lab). Also, multiple engineers working collaboratively can time-share use of a single analyzer, reducing the need for an additional analyzer for each engineer and increasing the cost effectiveness of the product.

1.7 Summit T28 PCI Express Protocol Analyzer Overview

Designed for developers and validators, the Teledyne LeCroy Summit T28™ is a Gen1/Gen2 PCI Express advanced verification system.

By leveraging years of experience in protocol analysis tools for emerging markets, Summit T28 blends sophisticated functionality with practical features to speed the development of PCI Express™ IP cores, semiconductors, bridges, switches, add-in boards, and systems.

The Teledyne LeCroy Summit T28 is Teledyne LeCroy's high performance PCI Express analyzer for customers in server, workstation, desktop, graphics, storage and network card markets.

1.7.1 Summit T28 Analyzer

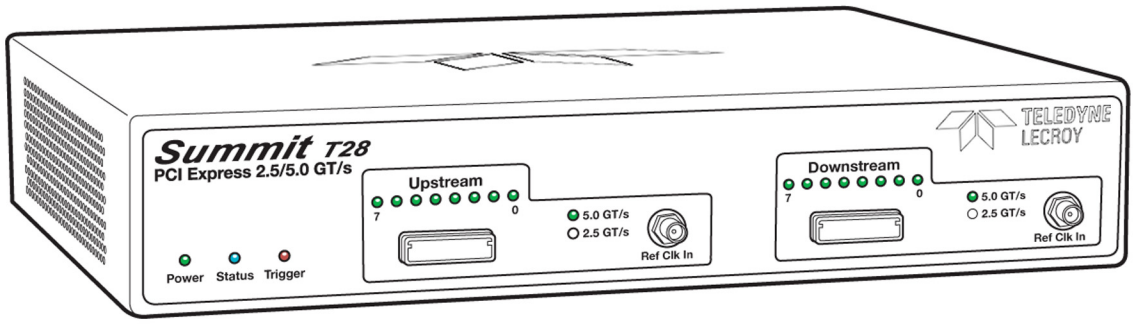


Figure 1.9: Summit T28 Analyzer

With advanced features such as data rates from 2.5 to 5.0 GBps, link widths from x1 to x8, and 4 GB of memory, the Summit T28 provides unmatched capability and flexibility for developers and users of advanced PCI Express products.

As with other Teledyne LeCroy PCI Express analyzers, the Summit T28 leverages the intuitive and powerful CATC Trace analysis system, embedding a deep understanding of the PCI Express protocol hierarchy and intricacies. The colorful, intuitive and easy-to-use graphical display allows you to quickly capture and validate PCI Express product designs.

In addition to a full suite of advanced hardware and software features, the Summit T28 has user-convenience and analysis features, such as support for automatic "lane swizzling," which allows a board developer to lay out a mid-bus probe pad with lanes in non-standard order, simplifying the design of the board. Internally, the Summit T28 maps the lanes back into their correct order and accurately displays the embedded bus traffic. An optional BitTracer™ mode allows bytes to be recorded as they come across the link, allowing debugging of PHY layer problems and combining the features of a logic analyzer format with a protocol analyzer format.

1.8 Summit T24 PCI Express Protocol Analyzer Overview

Designed for developers and validators, the Teledyne LeCroy Summit T24™ is a Gen1/Gen2 PCI Express advanced verification system.

By leveraging years of experience in protocol analysis tools for emerging markets, Summit T24 blends sophisticated functionality with practical features to speed the development of PCI Express™ IP cores, semiconductors, bridges, switches, add-in boards, and systems.

The Teledyne LeCroy Summit T24 is Teledyne LeCroy's high performance PCI Express analyzer for customers in server, workstation, desktop, graphics, storage and network card markets (see Figure 1.10 on page 43).

1.8.1 Summit T24 Analyzer

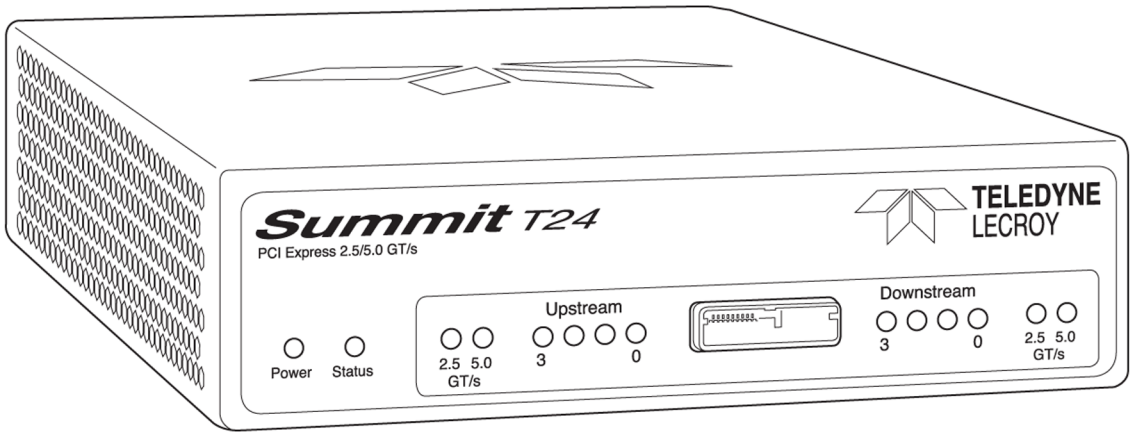


Figure 1.10: Summit T24 Analyzer

With advanced features such as data rates from 2.5 to 5.0 GBps, link widths from x1 to x4, and 2 GB of memory, the Summit T24 provides unmatched capability and flexibility for developers and users of advanced PCI Express products.

As with other Teledyne LeCroy PCI Express analyzers, the Summit T24 leverages the intuitive and powerful CATC Trace analysis system, embedding a deep understanding of the PCI Express protocol hierarchy and intricacies. The colorful, intuitive and easy-to-use graphical display allows you to quickly capture and validate PCI Express product designs.

An optional BitTracer™ mode allows bytes to be recorded as they come across the link, allowing debugging of PHY layer problems and combining the features of a logic analyzer format with a protocol analyzer format.

Chapter 2

Hardware Description

The PCI Express™ Protocol Suite software drives the Summit Analyzer family (T3-16, T3-8, T34, T28 and T24).

2.1 System Components: Summit T3-16 Analyzer

- Summit T3-16™ analyzer box
- One or two (for x8 or x16 recording) iPass Y probe data cables
- (optional) probes and interposers (see "Interposers and Probes" on page 92)

2.1.1 Front Panel: Summit T3-16 Analyzer

WARNING: Do not open the enclosure. There are no operator serviceable parts inside. Refer servicing to Teledyne LeCroy.

When powered on, the Summit T3-16 activates the user-accessible controls and LEDs on the front panel.

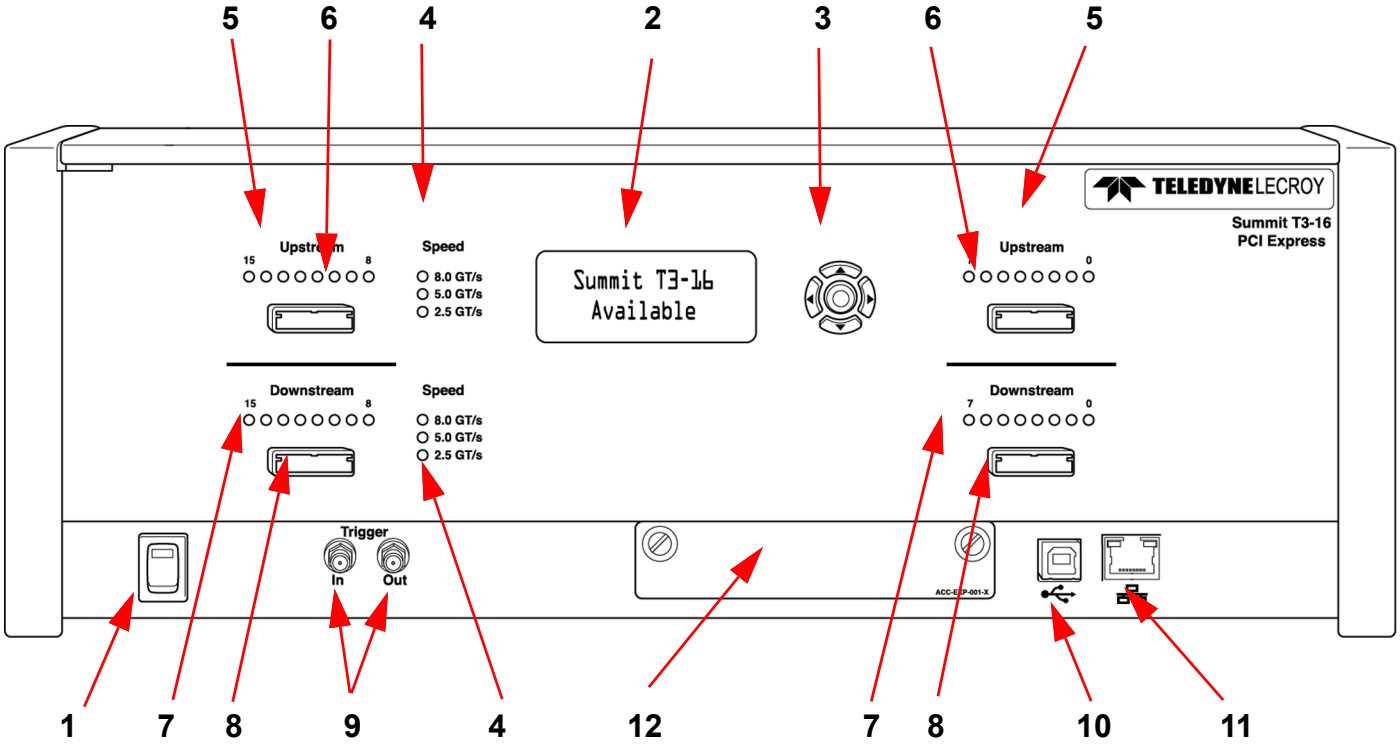


Figure 2.1: Front Panel: Summit T3-16 Analyzer

2.1.2 Front Panel Description: Summit T3-16 Analyzer

The Summit T3-16 Analyzer has the following features on the front panel:

Front Panel Features	Description
[1] Power Switch (black)	1 = On and 0 = Off.
[2] LCD Menu	Allows you to configure Summit T3-16 and view status.
[3] Navigation Buttons	Navigate through the LCD menu.
[4] Speed LEDs	Indicate speed setting the analyzer is using for each traffic direction.
[5] Upstream [15:0] LEDs	Lane activity for upstream lanes. OFF for electrical idle, orange for activity with errors detected, green for normal operation.
[6] Upstream [15:8] and Upstream [7:0] connectors	Connection to the probe for the capture of upstream direction of the link.
[7] Downstream [15:0] LEDs	Lane activity for downstream lanes. OFF for electrical idle, orange for activity with errors detected, green for normal operation.
[8] Downstream [15:8] and Downstream [7:0] connector	Connection to the probe for the capture of downstream direction of the link.

Front Panel Features	Description
[9] Trigger IN	Provide external trigger capabilities. You can use Trigger In to trigger the Analyzer from another device. Trigger Input has a 1.5 kohm pullup resistor to 3.3 volts and a 50 ohm RC termination. Threshold voltage for Trigger Input is 0.55 volts. Voltages below 0.4 volts will be detected as low, voltages above 0.7 volts will be detected as high. The minimal pulse width is 70ns for rising pulses and 20us for falling pulses. When Internal Triggering option is selected in the recording options, any edge of this signal will cause the analyzer to trigger.
[9] Trigger Out	Provide external trigger capabilities. You can configure Summit T3 to trigger external equipment using Trigger Out. Output buffer is 3.3 volts. The buffer can drive up to 32 mA of current and meet VOH (2.5 V) and VOL (0.5 V) thresholds. Output buffer can drive a 50 ohm DC load (such as scope input)
[10] USB Type B Host Machine Connector	To connect the Analyzer to the host machine using a USB connection.
[11] Ethernet Port	1 GIGE Connectivity allows connection to the analyzer through an Ethernet network.
[12] Expansion Slot	For CATC Sync Expansion Card to allow multiple Teledyne LeCroy analyzers to send synchronization and control messages to one another.

2.1.3 Rear Panel Description: Summit T3-16 Analyzer

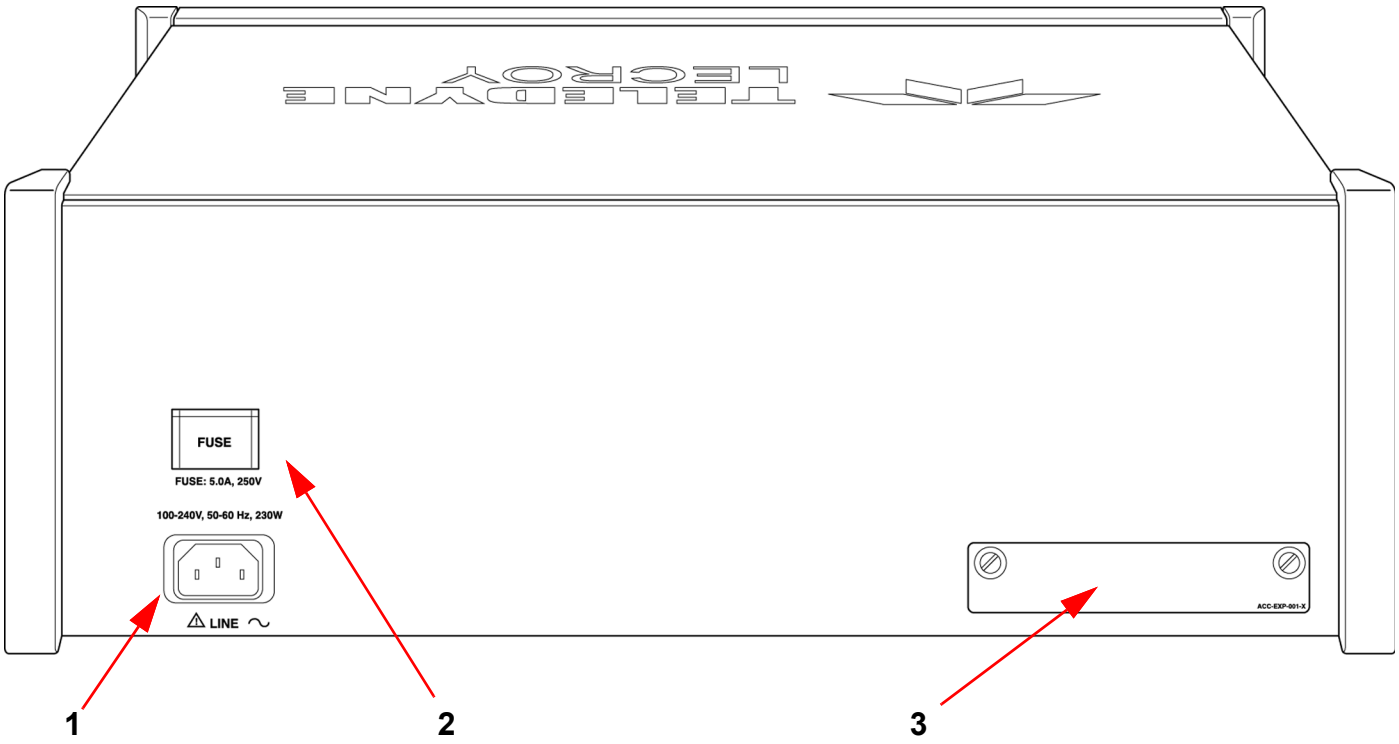


Figure 2.2: Rear Panel: Summit T3-16 Analyzer

The Summit T3-16 Analyzer has the following features on the rear panel:

Rear Panel Features	Description
[1] Wide-Range AC Connector Module	Standard Power Socket
[2] Fuse	250V AC, 5 Amps (Enclosed)
[3] Expansion Slot	For future use.

WARNING: For continued protection against fire, replace fuse only with the type and rating specified above.

2.2 System Components: Summit T3-8 Analyzer

- ❑ Summit T3-8 analyzer system
- ❑ AC Power Cable
- ❑ USB and Ethernet cables
- ❑ (optional) probes and interposers (see “Interposers and Probes” on page 92)

2.2.1 Front Panel Description: Summit T3-8 Analyzer

WARNING: Do not open the enclosure. No operator serviceable parts are inside.

When powered on, the Summit T3-8 analyzer activates the user-accessible controls and LEDs on the front panel.

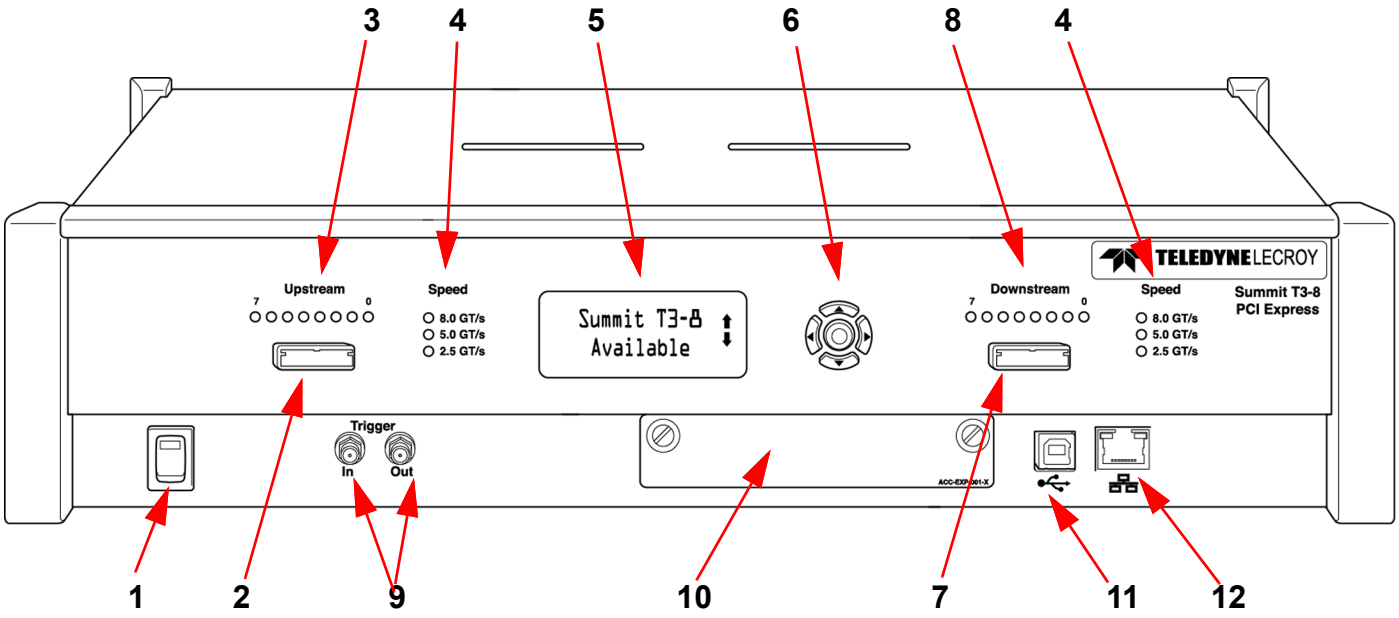


Figure 2.3: Front Panel: Summit T3-8 Analyzer

2.2.2 Front Panel Description: Summit T3-8 Analyzer

The Summit T3-8 Analyzer has the following features on the front panel:

Front Panel Features	Description
[1] Power Switch (black)	1 = On and 0 = Off.
[2] Upstream [7:0] connectors	Connection to the probe for the capture of upstream direction of the link.
[3] Upstream [7:0] LEDs	Lane activity for upstream lanes. OFF for electrical idle, orange for activity with errors detected, green for normal operation.

Front Panel Features	Description
[4] Speed LEDs	Indicate speed setting the analyzer is using for each traffic direction.
[5] LCD Menu	Allows you to configure Summit T3-8 and view status.
[6] Navigation Buttons	Navigate through the LCD menu.
[7] Downstream [7:0] connector	Connection to the probe for the capture of downstream direction of the link.
[8] Downstream [7:0] LEDs	Lane activity for downstream lanes. OFF for electrical idle, orange for activity with errors detected, green for normal operation.
[9] Trigger IN	Provide external trigger capabilities. You can use Trigger In to trigger the Analyzer from another device. Trigger Input has a 1.5 kohm pullup resistor to 3.3 volts and a 50 ohm RC termination. Threshold voltage for Trigger Input is 0.55 volts. Voltages below 0.4 volts will be detected as low, voltages above 0.7 volts will be detected as high. The minimal pulse width is 70ns for rising pulses and 20us for falling pulses. When Internal Triggering option is selected in the recording options, any edge of this signal will cause the analyzer to trigger.
[9] Trigger Out	Provide external trigger capabilities. You can configure Summit T3 to trigger external equipment using Trigger Out. Output buffer is 3.3 volts. The buffer can drive up to 32 mA of current and meet VOH (2.5 V) and VOL (0.5 V) thresholds.
[10] Expansion Slot	For CATC Sync Expansion Card to allow multiple Teledyne LeCroy analyzers to send synchronization and control messages to one another.
[11] USB Type B Host Machine Connector	To connect the Analyzer to the host machine using a USB connection.
[12] Ethernet Port	1 GIGE Connectivity allows connection to the analyzer through an Ethernet network.

2.2.3 Rear Panel Description: Summit T3-8 Analyzer

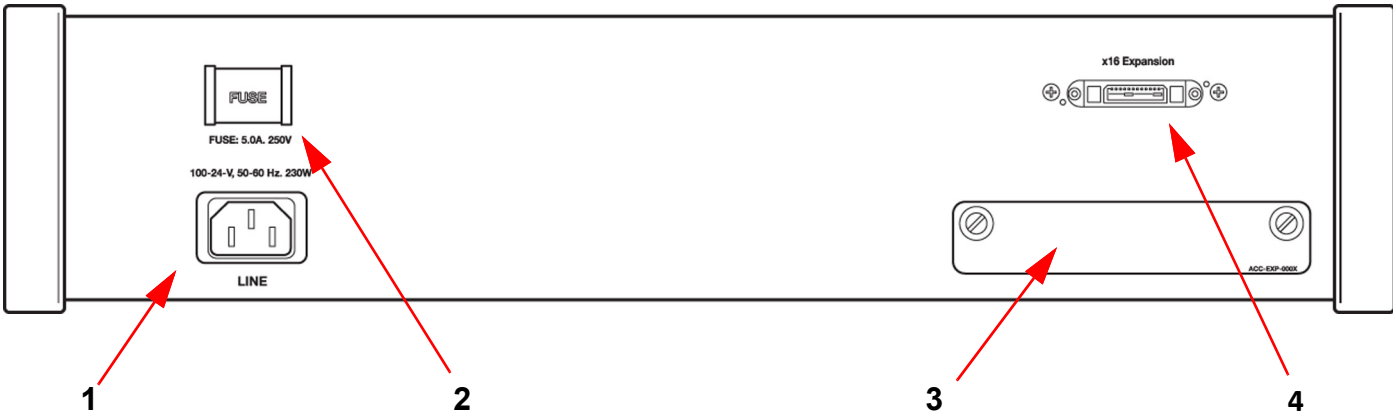


Figure 2.4: Rear Panel: Summit T3-8 Analyzer

The Summit T3-8 Analyzer has the following features on the rear panel:

Rear Panel Features	Description
[1] Wide-Range AC Connector Module	Standard Power Socket
[2] Fuse	250V AC, 5 Amps (Enclosed)
[3] Expansion Slot	For future use.
[4] x16 Expansion Connector	Used to connect two T3-8 systems using a special cable to record X16 traffic.

WARNING: For continued protection against fire, replace fuse only with the type and rating specified above.

2.3 Status and Config Display (Summit T3-16 and T3-8)

The Summit T3-16 and T3-8 Analyzers have front panel LCD displays which indicate the configuration and status of the device. For example, during initialization, the LCD panel displays boot status messages. See Figure 2.5.

2.3.1 LCD Display and Button Functions for Analyzer Host Connection Setup

The host connection settings of the Summit T3-16 and T3-8 can be configured from the unit itself. Five buttons are provided to navigate menus and input settings presented on the LCD display. When you first turn on the Analyzer, after initialization, the LCD displays **Summit T3-16 or Summit T3-8 Available** with two arrows pointing up and down as shown in the illustration below.

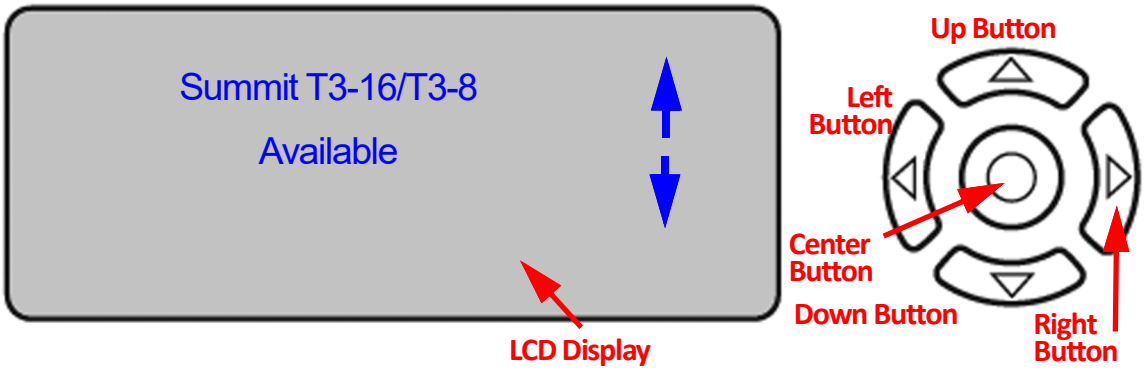


Figure 2.5: LCD Display and Button on the Front Panel

Press the **Up** ⇑ and **Down** ⇓ buttons to navigate through the following menu items:

- Displays current Static or Dynamic IP Address
- Summit T3-16/T3-8 SN (serial number)
- Connection
- Unit Name
- Set IP Configuration
- IP Mode Dynamic, or
- IP Mode Static

The **Left** ⇐ and **Right** ⇒ buttons are used to change the configuration properties.

The LCD will display **Button Inactive In This Menu Item** if the button does not serve any purpose for that selection.

Perform the following steps to set IP Configuration, Static on Dynamic IP using the buttons and the LCD display on the Analyzer:

2.3.1.1 Set IP Configuration

After powering on your unit and after waiting for it to initialize (**Initializing.....**), you can scroll through the LCD Menu display by pressing the **Down Button**:

- Main menu -> IP Address -> **Available** (Unit not in use by other user)

Scroll through the other menus by pressing the **Down Button:**

- Main Menu -> Product Name -> **Serial Number**
- Main Menu -> IP Mode -> **Dynamic**
  - The display will show you which IP Configuration mode your product is currently in: Dynamic or Static. In this case it is in Dynamic IP Address Mode
- Main Menu -> **Set IP Configuration**
  - From this menu you can change the IP Configuration from Dynamic to Static or from Static to Dynamic
- Main menu -> IP Address -> **Available** (Unit not in use by other user)

2.3.1.2 Changing from Dynamic to Static IP Mode

If your unit is in Dynamic IP Mode you can change it to Static IP Mode and manually set the IP Address by following the steps below:

To set a Static IP Address:

1. After initialization, press the **Down Button** to ensure your unit is in **Dynamic IP Mode**.
2. Press the **Down Button** until you see the **Set IP Configuration.**
3. Press the **Center Button** once to select **Set IP Configuration.**
   Set IP Mode -> Static is displayed in the LCD display.
4. Press the **Center Button** once to select **Set IP Mode Static.**
   The **Static IP** address (for example: 188.168.040.036) is displayed in the LCD display.
5. Press the **Center Button** once to set the **Static IP address.**
   The first numeral of the IP address will blink.
6. Use the **Up Button** or **Down Button** to change the IP Address.
7. Press the **Right Button** or **Left Button** to move to the right or left to change each component of the static or dynamic IP address and change it using step 6.
8. Once the IP Address is selected, press the **Center Button** to set the new **Static IP Address**.
9. The new **Static IP Address** will be displayed.
10. Press the **Up Button** once and "**Accept and Reboot"** will be displayed.
11. Press the **Center Button** and "**Center Button to Confirm Reboot"** will be displayed.
12. If you want the new **Static IP Address** to be stored and your unit to **Reboot** press the **Center Button: Rebooting ..... will be displayed.**
    a. Press any other button and your changes will be cancelled.
12. After **Rebooting** has completed, to check that you are in **Static IP Mode**, just scroll through the Main Menu using the **Down Button.**

2.3.1.3 Changing from Static to Dynamic IP Mode

If your unit is in Static IP Mode you can change it to Dynamic IP Mode, the IP Address will be set automatically by the network using DHCP.

To change from a Static IP address to a Dynamic IP address follow the steps below:

1. Ensure your unit is in Static IP Mode by scrolling through the Menus displayed on the LCD by pressing the down button. Main Menu -> IP Mode -> **Static.**
2. Press the **Down Button** one more time and **Set IP Configuration** should be displayed.
3. Press the **Center Button** once to select **Set IP Configuration.**
   Set IP Mode -> Dynamic should be displayed.
4. Press the **Center Button** once to select **Set IP Mode Dynamic.**
5. "**Accept and Reboot**" should be displayed. Press the **Center Button** once.
6. **"Center Button to Confirm Reboot"** should be displayed.
7. If you want the new Dynamic IP Address to be stored and your unit to Reboot press the **Center Button: Rebooting ..... will be displayed.**
   a. Press any other button and your changes will be canceled.
8. To check that you are in Dynamic IP Mode, just scroll through the Main Menu using the **Down Button.**

Note: In case the device is often moved from one subnet to the other, it is recommended to set the IP Mode to Dynamic and to configure the DHCP server so that the device always receives the same (known) IP address. Many DHCP servers allow this type of static allocation based on the device's MAC address.

2.3.1.4 Setting the Gateway and Subnet Mask

Note: Setting the Gateway and Subnet Mask require a detailed knowledge of your network.

1. Ensure that you are in Static IP Mode by following the steps in "Set IP Configuration" on page 53 and "Changing from Dynamic to Static IP Mode" on page 53 if necessary.
2. Press the **Down Button** to get to the **Set IP Configuration** Menu.
3. Press the **Center Button** and then the **Down Button** to get to the **Set IP Mode Static** Menu.
4. Press the **Center Button** once and then press the **Down Button** to get to the **Subnet Mask** Menu.
5. To set the **Subnet Mask**: Press the **Center Button** and the first numeral of the **Subnet Mask** will have a arrow below it pointing to it.
6. Use the **Up Button** or **Down Button** to change the **Subnet Mask**.
7. Press the **Right Button** or **Left Button** to move to the right or left to change each component of the **Subnet Mask** and change it using step 6.
8. Once the **Subnet Mask** is selected, press the **Center Button** to set and display the new **Subnet Mask**.

9. The press the **Down Button** to get to the **Gateway Address** Menu.
10. To set the **Gateway Address**: Press the **Center Button** and the first numeral of the **Gateway Address** will have a arrow below it pointing to it.
11. Use the **Up Button** or **Down Button** to change the **Gateway Address**.
12. Press the **Right Button** or **Left Button** to move to the right or left to change each component of the **Gateway Address** and change it using step 11.
13. Once the **Gateway Address** is selected, press the **Center Button** to set and display the new **Gateway Address**.
14. Press the **Up Button** to confirm the **Subnet Mask** and then press the **Up Button** to confirm the **Static IP Address.**
15. Press the **Up Button** one more time to display **"Accept and Reboot".**
16. Press the **Center Button** once and the LCD display will read "**Center Button to Confirm Reboot".**
17. If you want the new **Subnet Mask, Gateway Address** and **Static IP Address** to be stored and your unit to Reboot press the **Center Button: Rebooting ..... will be displayed.**
    a. Press any other button and your changes will be canceled.

2.4 System Components: Summit T34 Analyzer

- ❑ Summit T34 analyzer system
- ❑ AC Power Cable
- ❑ USB and Ethernet cables
- ❑ (optional) probes and interposers (see “Interposers and Probes” on page 92)

2.4.1 Front Panel Description: Summit T34 Analyzer

WARNING: Do not open the enclosure. No operator serviceable parts are inside.

When powered on, the Summit T34 analyzer activates the user-accessible controls and LEDs on the front panel.

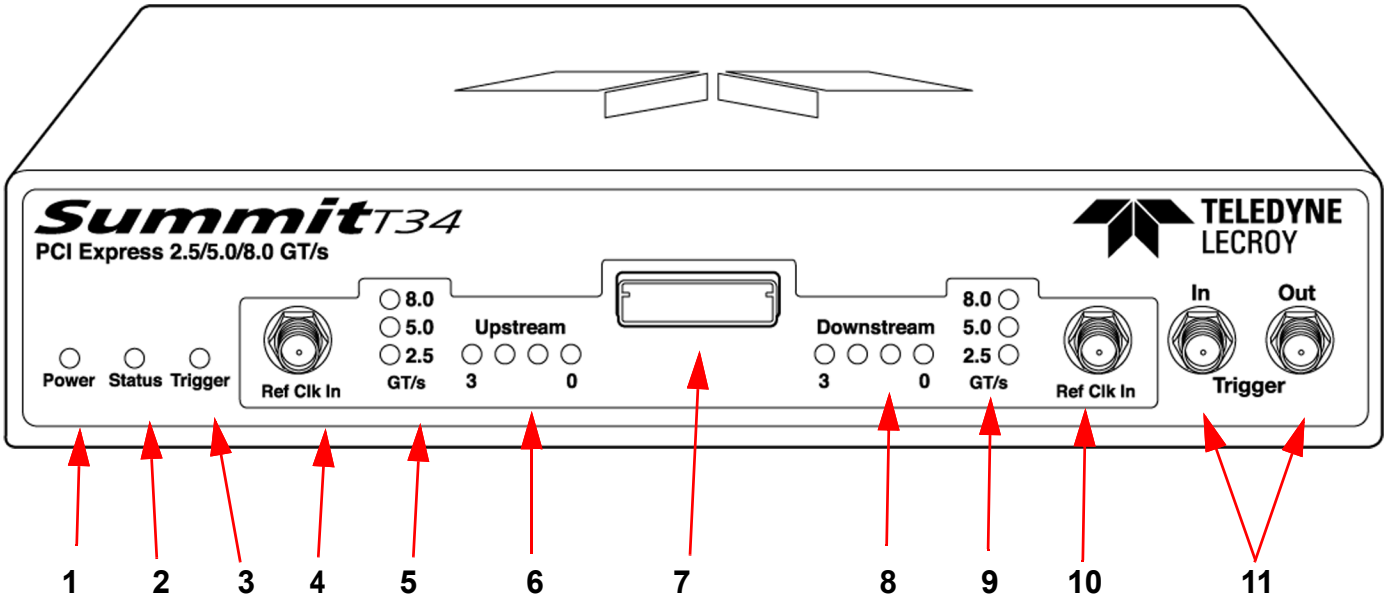


Figure 2.6: Front Panel: Summit T34 Analyzer

Note: The reference clock from the PCIe bus is routed by the slot interposer through the straight x4 iPass cable to the Summit T34 analyzer.

The Summit T34 Analyzer has the following features on the front panel:

Front Panel Features	Description
[1] Power LED	Lights when power is On.
[2] Status LED	Displays the connection status of the link. Red - Error condition. Try using the PCIe Protocol Analysis application to clear the error. Please contact the factory if this does not work. Green - Configuring system. Blue - Unit ready/connected.
[3] Trigger LED	Lights when Summit T34 triggers on an event.
[4] Ref Clk In	Provides an optional alternative connection from an external reference clock source to the Summit T34 analyzer Upstream direction. (Reference Clock In) **Note**: In standard configuration, the Summit T34 analyzer uses the reference clock from a probe cable from the interposer.
[5] Speed LEDs	Indicate speed setting the analyzer is using for Upstream traffic direction.
[6] Upstream [3:0] LEDs	Indicates which Upstream Lanes are currently showing activity. OFF for electrical idle state, orange for activity with errors detected, green for normal operation.
[7] Upstream [3:0] and Downstream [3:0] connector	Connection to the probe for the capture of both upstream and downstream directions of the link.
[8] Downstream [3:0] LEDs	Indicates which Downstream Lanes are currently showing activity. OFF for electrical idle state, orange for activity with errors detected, green for normal operation.
[9] Speed LEDs	Indicates current speed the analyzer is using for the Downstream traffic direction.
[10] Ref Clk In	Provides an optional alternative connection from an external reference clock source to the Summit T34 analyzer Upstream direction. (Reference Clock In) **Note**: In standard configuration, the Summit T34 analyzer uses the reference clock from a probe cable from the interposer.
[11] Trigger In	Provide external trigger capabilities. You can use Trigger In to trigger the Analyzer from another device. When Internal Triggering option is selected in the recording options, any edge of this signal will cause the analyzer to trigger.
[11] Trigger Out	Provide external trigger capabilities. You can configure Summit T34 to trigger external equipment using Trigger Out. When Internal Triggering option is selected in the recording options, any edge of this signal will cause the analyzer to trigger.

2.4.2 Rear Panel Description: Summit T34 Analyzer

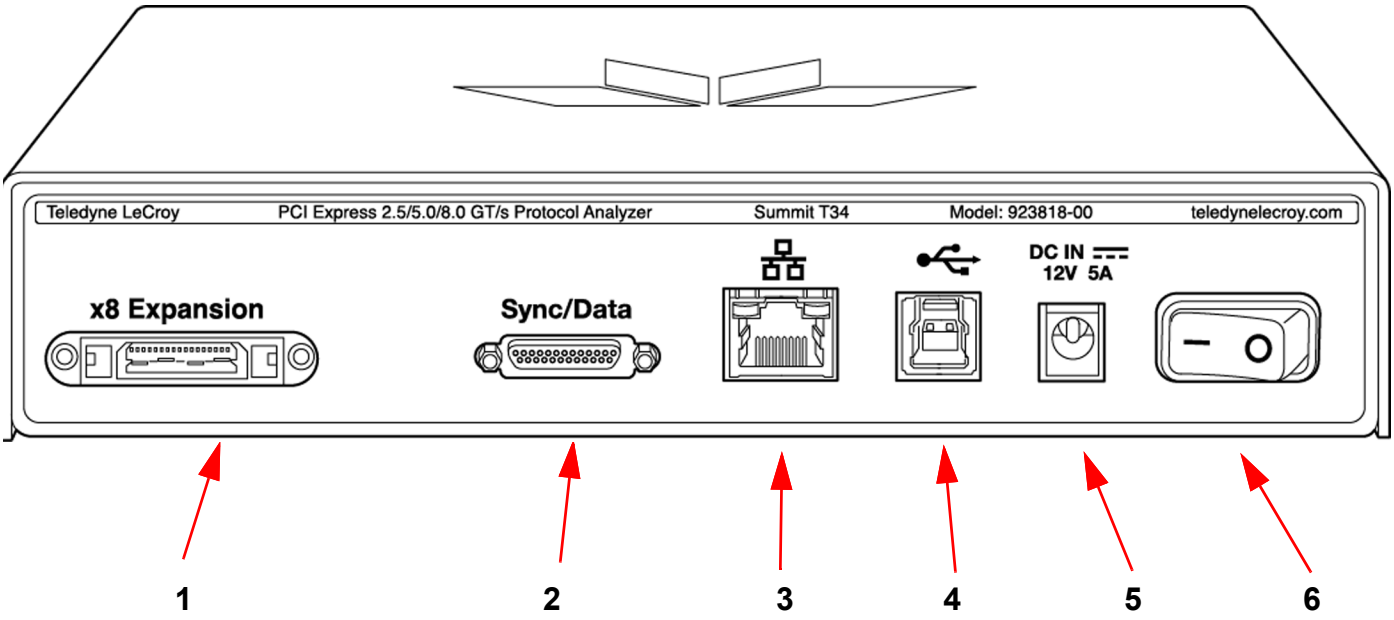


Figure 2.7: Rear Panel: Summit T34 Analyzer

The Summit T34 Analyzer has the following features on the rear panel:

Front Panel Features	Description
[1] x8 Expansion	Used to connect two T34 systems using a special cable to record X8 traffic.
[2] Sync Data	Use a special cable to allow multiple Teledyne LeCroy analyzers to send synchronization and control messages to one another. This connection is also required for x8 Expansion.
[3] Ethernet Port	1 GIGE Connectivity allows connection to the analyzer through an Ethernet network.
[4] USB Type B Host Machine Connector	To connect the Analyzer to the host machine using a USB connection.
[5] DC IN	12V, 7A
[6] Power Switch (black)	1 = On and 0 = Off

WARNING: Do not open the enclosure. No operator serviceable parts are inside.

TABLE 2.1: Electrical Specifications

External CLOCK						
		min	typ	max	Unit	Comments
Vi	Input Voltage	250		1000	mV	ac-coupled Fmax = 200 MHz
TRIGGER IN BNC/SMA						
		min	typ	max	Unit	Comments
VIL	Low-Level Input Voltage	-0.2		0.5	V	
VIH	High-Level Input Voltage	1		5.2	V	
Input Termination	ac		50		ohms	
	dc		1.5k		ohms	
TRIGGER OUT BNC/SMA						
		min	typ	max	Unit	Comments
VOL	Low-Level Output Voltage	0		0.55	V	Rl = 50 ohm Fmax = 40 MHz
VOH	High-Level Output Voltage	2.3			V	Rl = 50 ohm Fmax = 40 MHz
External Data						
		min	typ	max	Unit	Comments
VIL	Low-Level Input voltage	-0.2		0.4	V	
VIH	High-Level Input Voltage	1		5.2	V	
Input Termination	ac		50		ohms	
	dc		100k		ohms	
Tmin_pulse-width	Minimum Pulse Width Time	5			nS	

2.5 System Components: Summit T28 Analyzer

- ❑ Summit T28™ analyzer system
- ❑ DC Power Adapter, 12 volts, and AC power cable
- ❑ USB cable
- ❑ (optional) probes and interposers (see "Interposers and Probes" on page 92)

2.5.1 Front Panel Description: Summit T28 Analyzer

WARNING: Do not open the enclosure. No operator serviceable parts are inside.

When powered on, the Summit T28 activates the user-accessible controls and LEDs on the front panel.

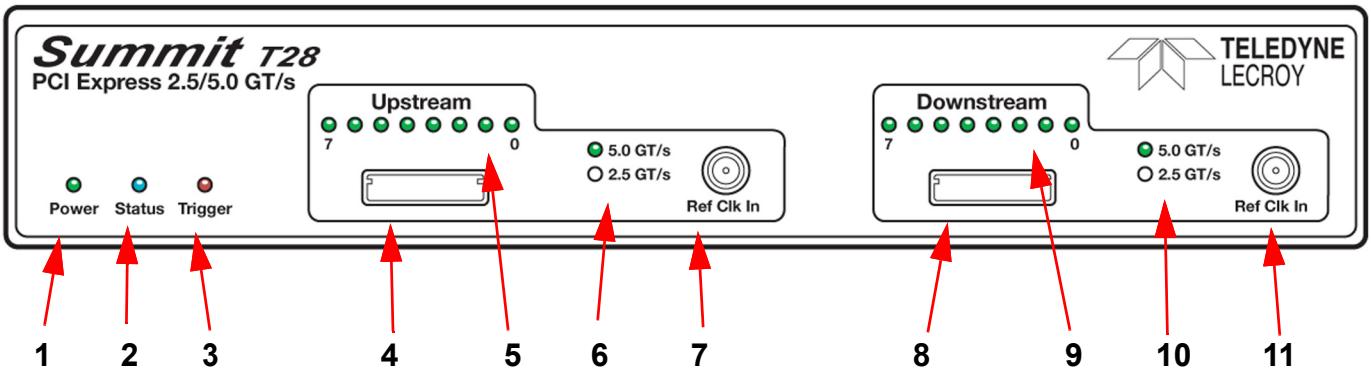


Figure 2.8: Front Panel: Summit T28 Analyzer

Note: The reference clock from the PCIe bus is routed by the slot interposer through the straight x8 iPass cable to the Summit T28 analyzer.

The Summit T28 Analyzer has the following features on the front panel:

Front Panel Features	Description
[1] Power LED	Lights when power is On.
[2] Status LED	Displays the connection status of the link. Red - Error condition. Try using the PCIe Protocol Analysis application to clear the error. Please contact the factory if this does not work. Green - Configuring system. Purple - Waiting for connection. Blue - Unit ready/connected.
[3] Trigger LED	Lights when Summit T28 triggers on an event.

Front Panel Features	Description
[4] Upstream [7:0] connector	Connection to the probe for the capture of upstream direction of the link.
[5] Upstream [7:0] Lane Activity LEDs	Indicates which Upstream Lanes are currently showing activity. OFF for electrical idle state, orange for activity with errors detected, green for normal operation.
[6] Speed LEDs	Indicates speed setting the analyzer is using for Upstream traffic direction.
[7] Ref Clk In	Provides an optional alternative connection from an external reference clock source to the Summit T28 analyzer Upstream direction. (Reference Clock In) **Note**: In standard configuration, the Summit T28 analyzer uses the reference clock from a probe cable from the interposer.
[8] Downstream [7:0] connector	Connection to the probe for the capture of downstream direction of the link.
[9] Downstream [7:0] Lane Activity LEDs	Indicates which Downstream Lanes are currently showing activity. OFF for electrical idle state, orange for activity with errors detected, green for normal operation.
[10] Speed LEDs	Indicates speed setting the analyzer is using for Downstream traffic direction.
[11] Ref Clk In	Provides an optional alternative connection from an external reference clock source to the Summit T28 analyzer Downstream direction. (Reference Clock In) **Note**: In standard configuration, the Summit T28 analyzer uses the reference clock from a probe cable from the interposer.

2.5.2 Rear Panel Description: Summit T28 Analyzer

The Summit T28 Analyzer rear panel contains:

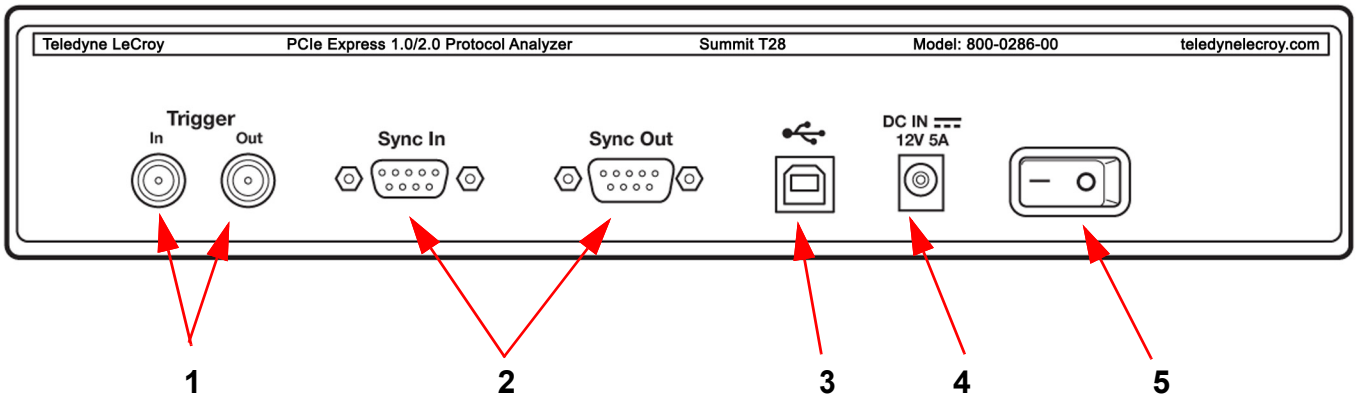


Figure 2.9: Rear Panel: Summit T28 Analyzer

The Summit T28 Analyzer has the following features on the rear panel:

Front Panel Features	Description
[1] Trigger In	Provide external trigger capabilities. You can use Trigger In to trigger the Analyzer from another device. The minimal pulse width for Trigger In is 20ns. The Trigger Input has the following characteristics: Trigger Input has a 1.5 k ohm pullup resistor to 3.3 volts. Trigger Input also has a 50 ohm RC termination. Threshold voltage for Trigger Input is 0.8 volts. Voltages below 0.6 volts will be detected as low, voltages above 1.0 volts will be detected as high. When Internal Triggering option is selected in the recording options, any edge of this signal will cause the analyzer to trigger.
[1] Trigger Out	Provide external trigger capabilities. You can configure Summit T28 to trigger external equipment using Trigger Out. The Trigger Output has the following characteristics: Trigger Output buffer is 3.3 volts. The buffer can drive up to 32 mA of current and meet VOH (2.5 V) and VOL (0.5 V) thresholds. Trigger Output buffer can drive a 50 ohm DC load (such as scope input).
[2] Sync In	Allows multiple Teledyne LeCroy analyzers to send synchronization and control messages to one another.
[2] Sync Out	Allows multiple Teledyne LeCroy analyzers to send synchronization and control messages to one another.
[3] USB Type B Host Machine Connector	To connect the Analyzer to the host machine using a USB connection.
[4] DC IN	12V, 5A
[5] Power Switch (black)	1 = On and 0 = Off

WARNING: Do not open the enclosure. No operator serviceable parts are inside.

2.6 System Components: Summit T24 Analyzer

- ❑ Summit T24™ analyzer system
- ❑ DC Power Adapter, 12 volts, and AC power cable
- ❑ USB cable
- ❑ (optional) probes and interposers (see “Interposers and Probes” on page 92)

2.6.1 Front Panel Description: Summit T24 Analyzer

WARNING: Do not open the enclosure. No operator serviceable parts are inside.

When powered on, the Summit T24 analyzer activates the user-accessible controls and LEDs on the front panel.

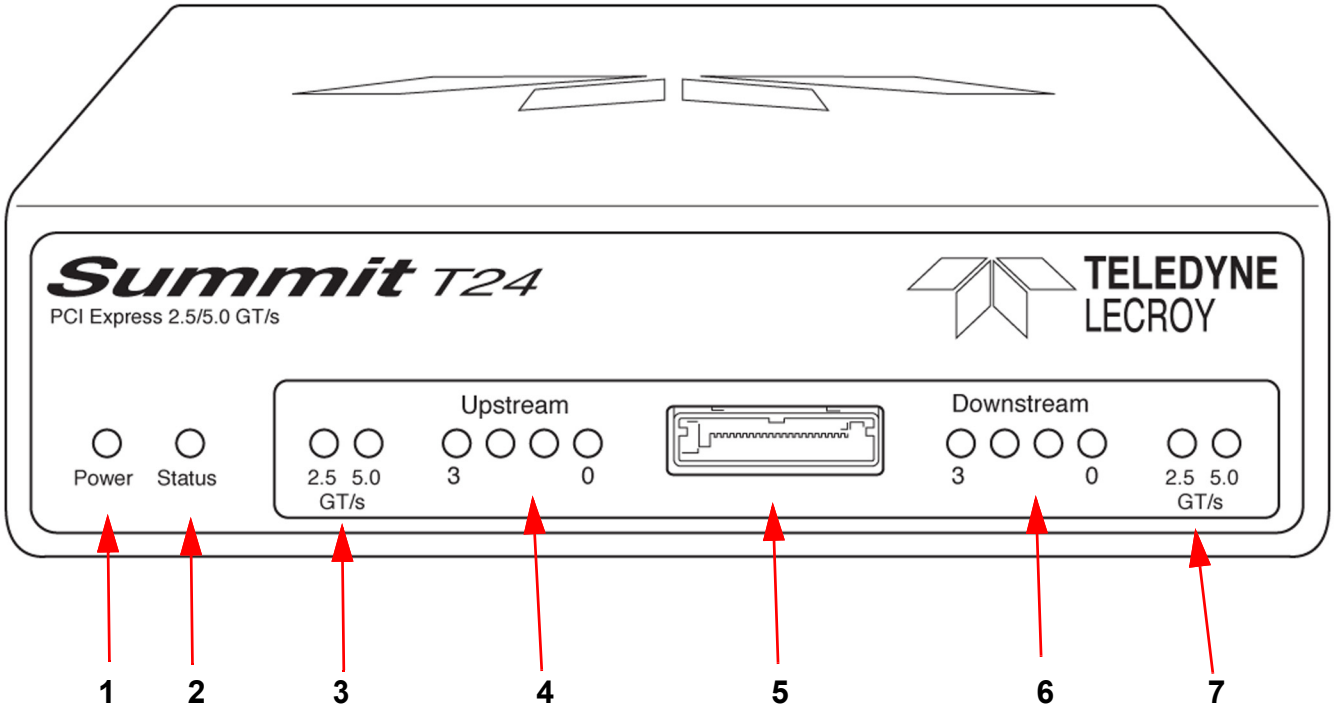


Figure 2.10: Front Panel: Summit T24 Analyzer

The Summit T24 Analyzer has the following features on the front panel:

Front Panel Features	Description
[1] Power LED	Lights when power is On.
[2] Status LED	Displays the connection status of the link. Red - Error condition. Try using the PCIe Protocol Analysis application to clear the error. Please contact the factory if this does not work. Green - Configuring system. Purple - Waiting for connection. Blue - Unit ready/connected.
[3] Speed LEDs	Indicates speed setting the analyzer is using for Upstream traffic direction.
[4] Upstream [3:0] Lane Activity LEDs	Indicates which Upstream Lanes are currently showing activity. OFF for electrical idle state, orange for activity with errors detected, green for normal operation.
[5] Upstream [3:0] and Downstream [3:0] connector	Connection to the probe for the capture of both upstream and downstream directions of the link.
[6] Downstream [3:0] Lane Activity LEDs	Indicates which Downstream Lanes are currently showing activity. OFF for electrical idle state, orange for activity with errors detected, green for normal operation.
[7] Speed LEDs	Indicates speed setting the analyzer is using for Downstream traffic direction.

2.6.2 Rear Panel Description: Summit T24 Analyzer

The Summit T24 analyzer rear panel contains:

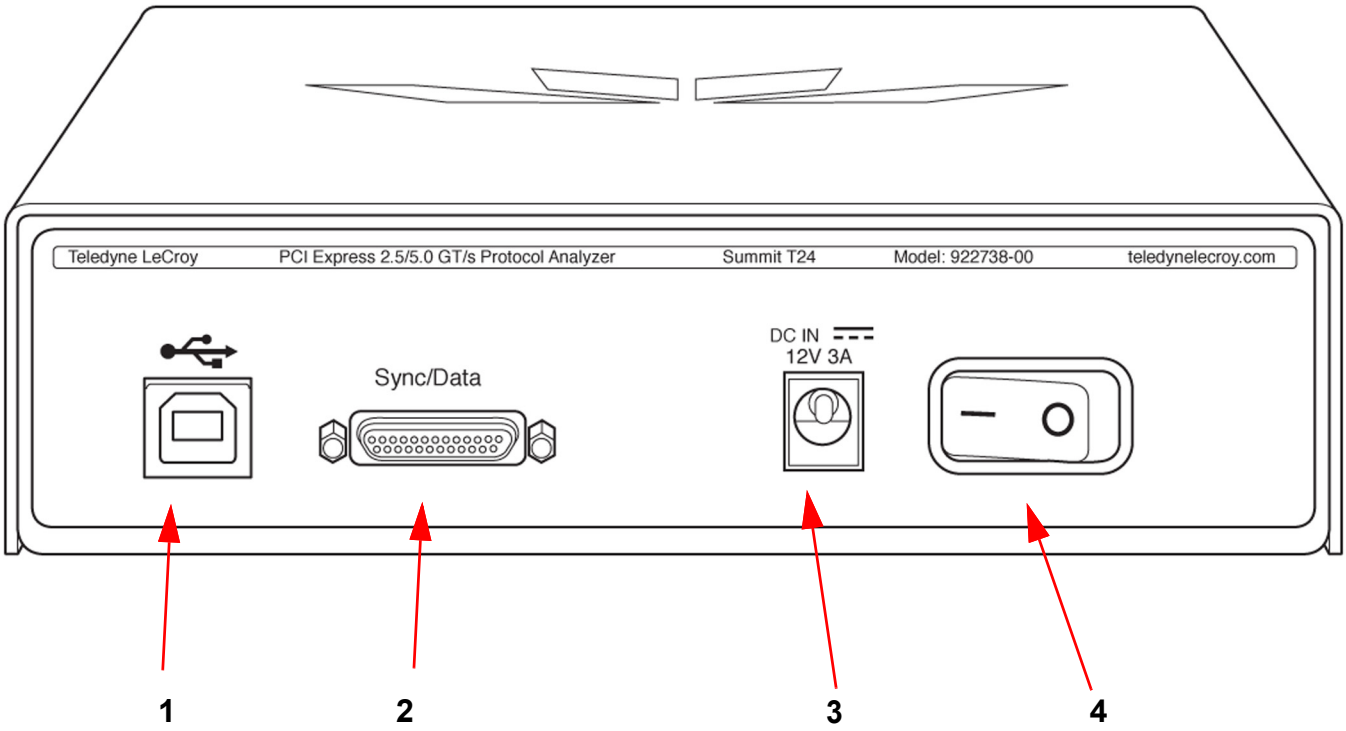


Figure 2.11: Rear Panel: Summit T24 Analyzer

The Summit T24 Analyzer has the following features on the rear panel:

Front Panel Features	Description
[1] USB Type B Host Machine Connector	To connect the Analyzer to the host machine using a USB connection.
[2] Sync/Data	Allows multiple Teledyne LeCroy analyzers to send synchronization and control messages to one another.
[3] DC IN	12V, 3A
[4] Power Switch (black)	1 = On and 0 = Off

WARNING: Do not open the enclosure. No operator serviceable parts are inside.

Chapter 3

Installation and Setup

3.1 Installing the PCIe Protocol Analysis software

PCIe Protocol Analysis operates all of Teledyne LeCroy's PCI Express protocol Analyzer and Exerciser products:

The PCIe Protocol Analysis is supported on systems using a Microsoft® Windows®-based host machine running Windows Server 2016, Windows Server 2019 and Windows 10 64-bit operating systems and serves as the interface for the Exerciser and/or Analyzer.

3.1.1 Downloading the PCIe Protocol Analysis

You can download the latest version of the PCIe Protocol Analysis software from the following site:

http://teledynelecroy.com/sw/pciexpress/

Note: First-time user registration is required.

3.1.2 Windows Server 2016/2019

If you are using Windows Server 2016/2019, the Teledyne LeCroy PCIe Protocol Analysis needs to be added to the firewall exceptions to ensure that the application can find the analyzers over your Ethernet network.

To add the PCIe Protocol Analysis application to the firewall exceptions perform the following steps.

1. Open the Control Panel. See Figure 3.1 on page 68.

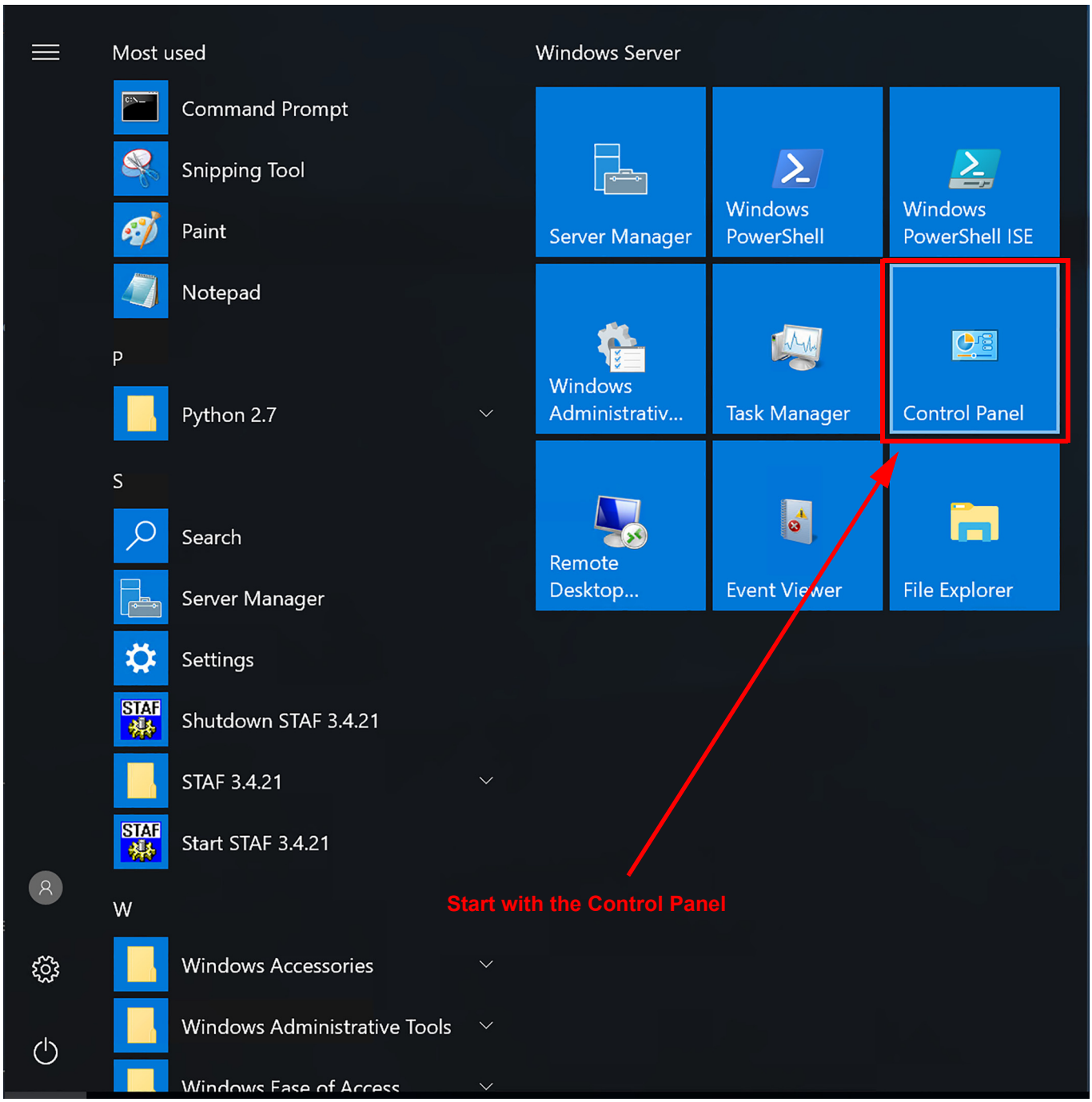


Figure 3.1: Windows Server 2016/2019: Start Menu -> Control Panel

2. From the Control Panel. select the “Systems and Security” screen. See Figure 3.2.

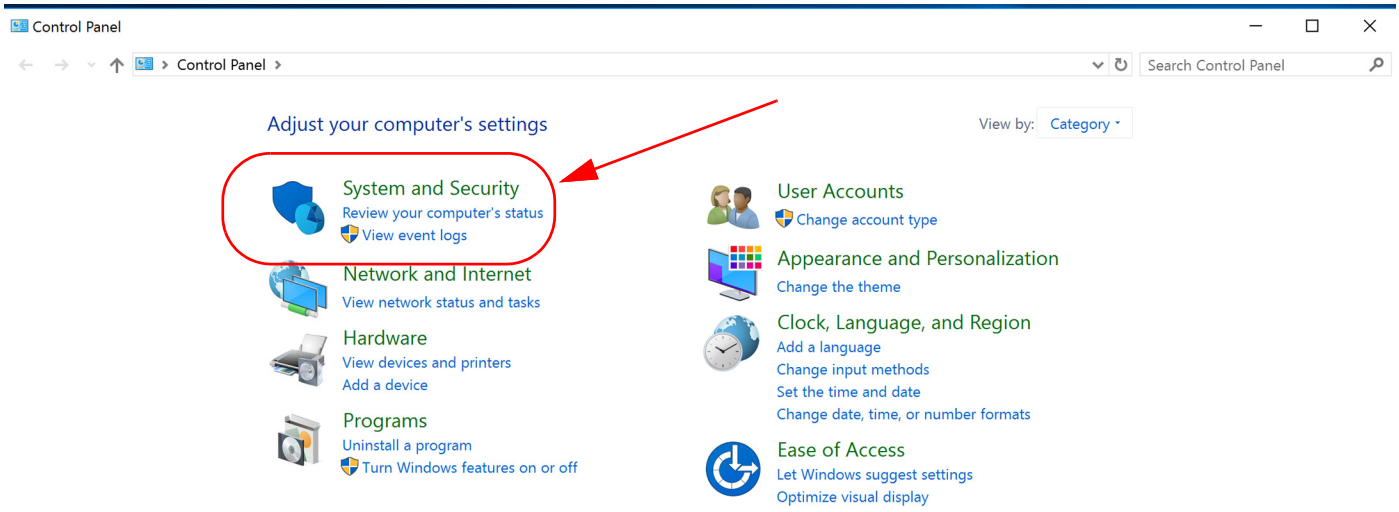


Figure 3.2: Windows Server 2016/2019: Control Panel -> System and Security Screen

3. From the Control Panel -> System and Security Screen, select “Allow an App through Windows Firewall”. See Figure 3.3.

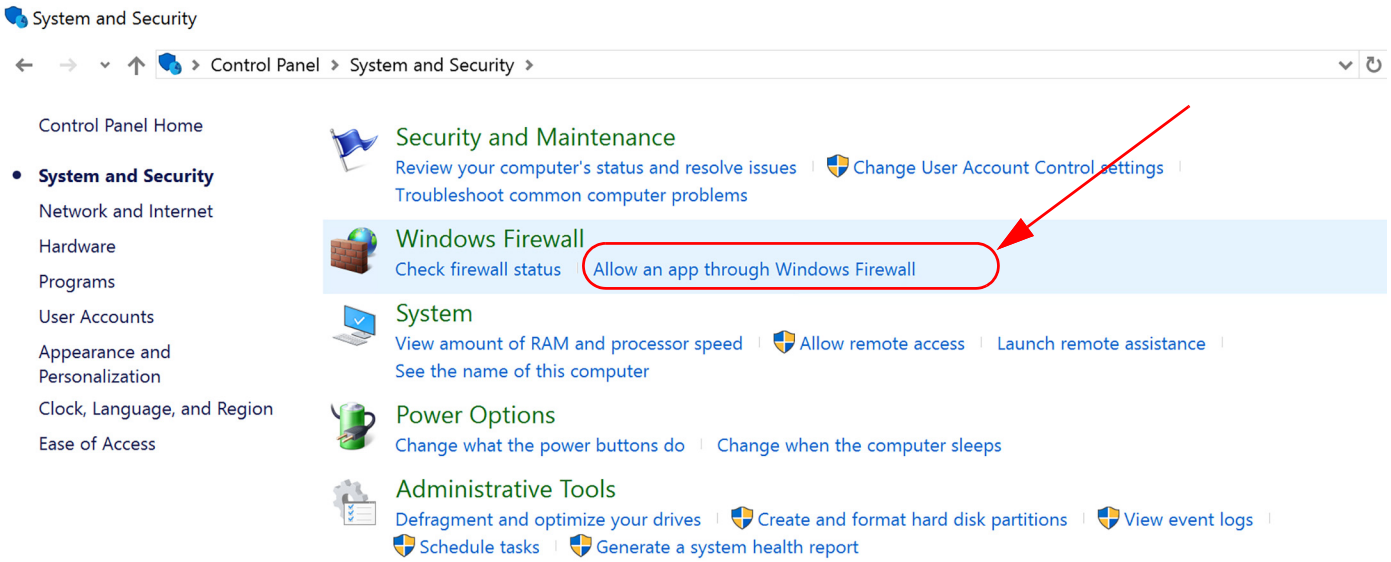


Figure 3.3: Windows Server 2016/2019: Allow an App Through Windows Firewall

4. From the Windows Firewall screen -> Allow apps to communicate through Windows Firewall, select “Change settings”, then select “Allow another app”. See Figure 3.4.

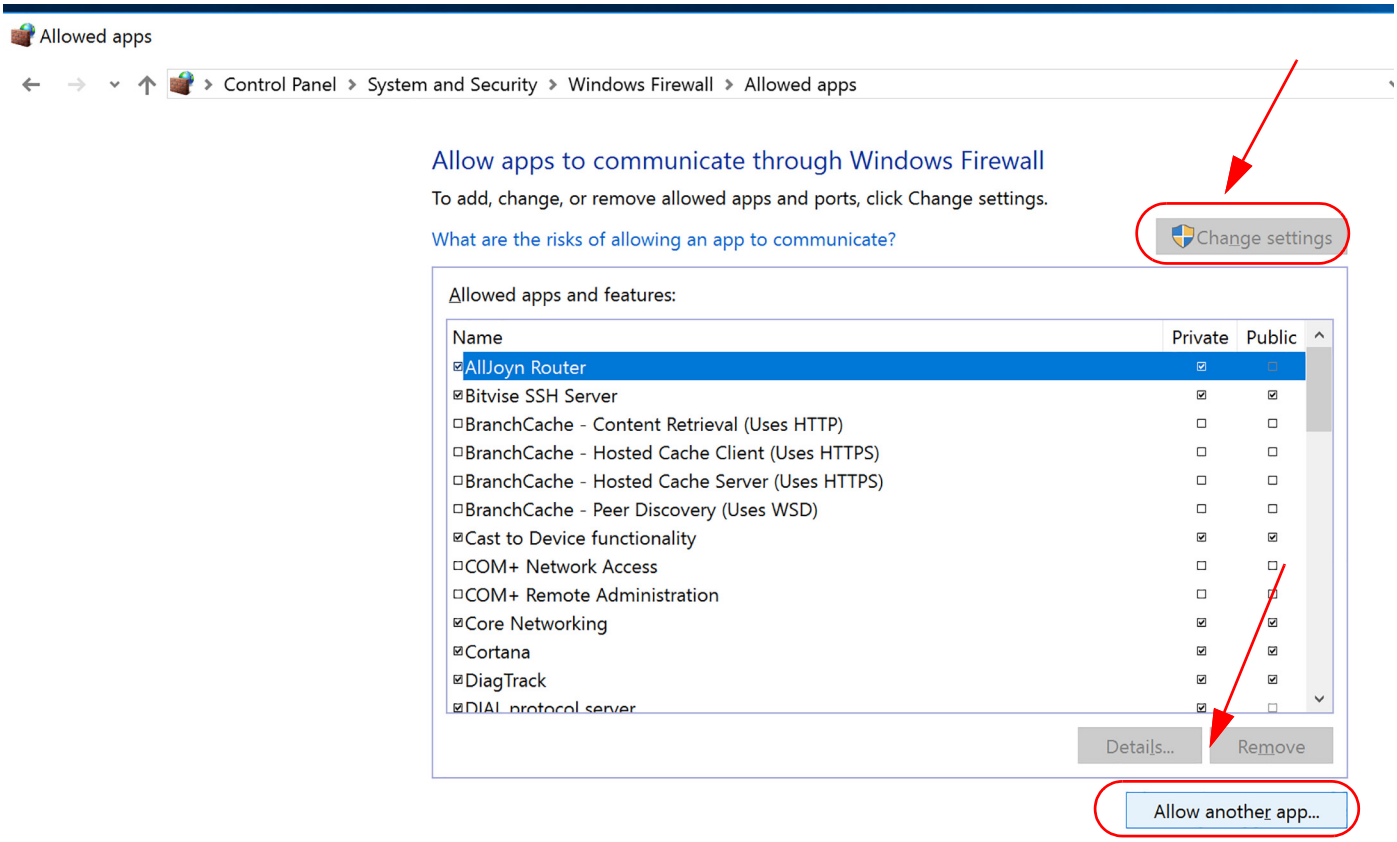


Figure 3.4: Windows Server 2016/2019: Change Settings -> Allowed Another app

5. From the User Account Control screen, select “Yes”. Figure 3.5.

Note: This screen may be optional if you have already allowed Microsoft Windows to make changes to your computer.

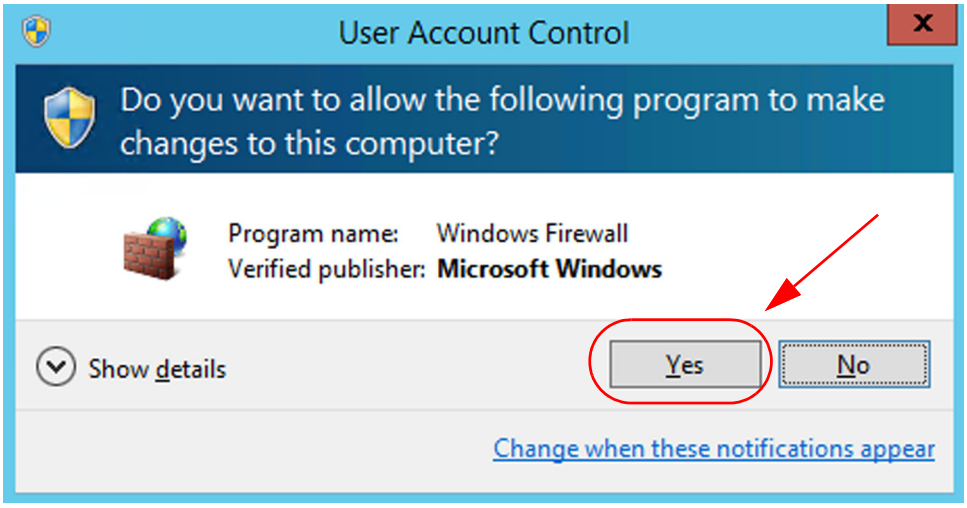


Figure 3.5: Windows Server 2016/2019: User Account Control

6. From the “Add an app” screen, select the Browse button. See Figure 3.6.

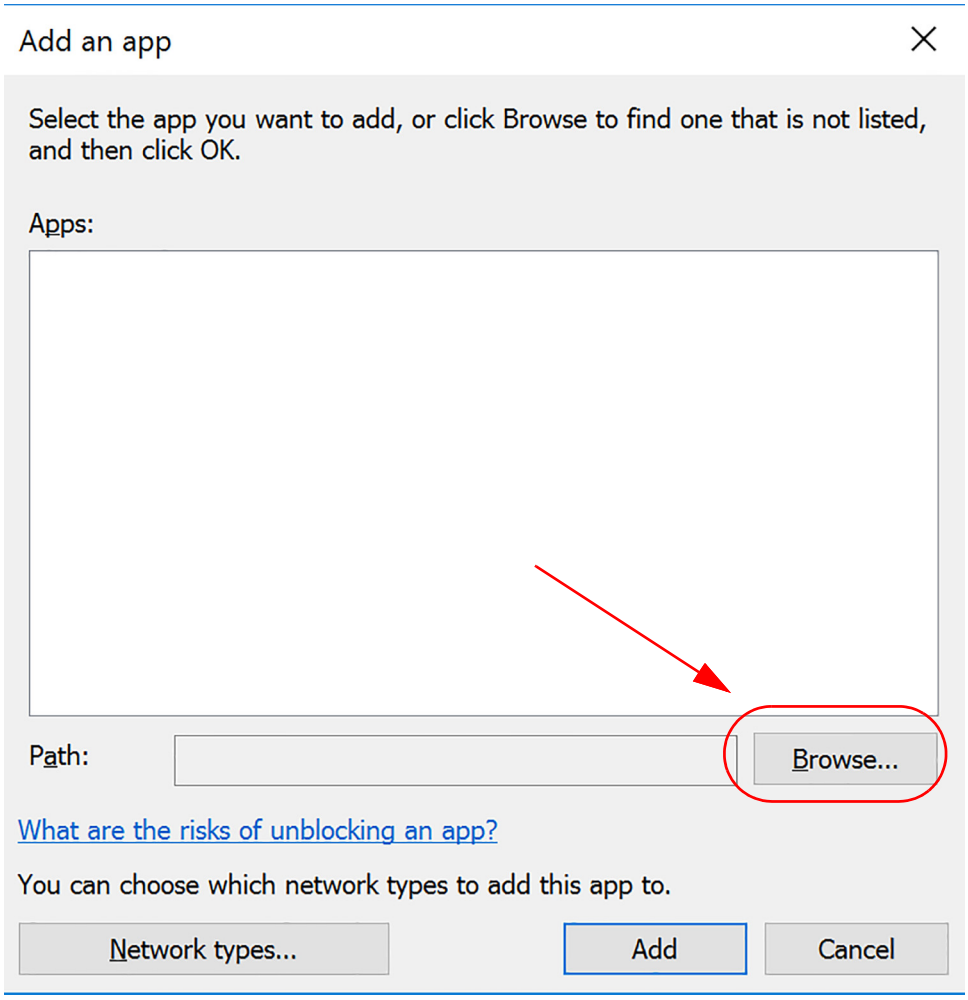


Figure 3.6: Windows Server 2016/2019: Add an App

7. In the Browse window navigate to the location of the installation directory for the PCIe Protocol Analysis you are installing. The Teledyne LeCroy PCIe Protocol Analysis software is typically installed on your machine in the C:\Program Files\LeCroy\PCIe Protocol Suite directory. See Figure 3.7.

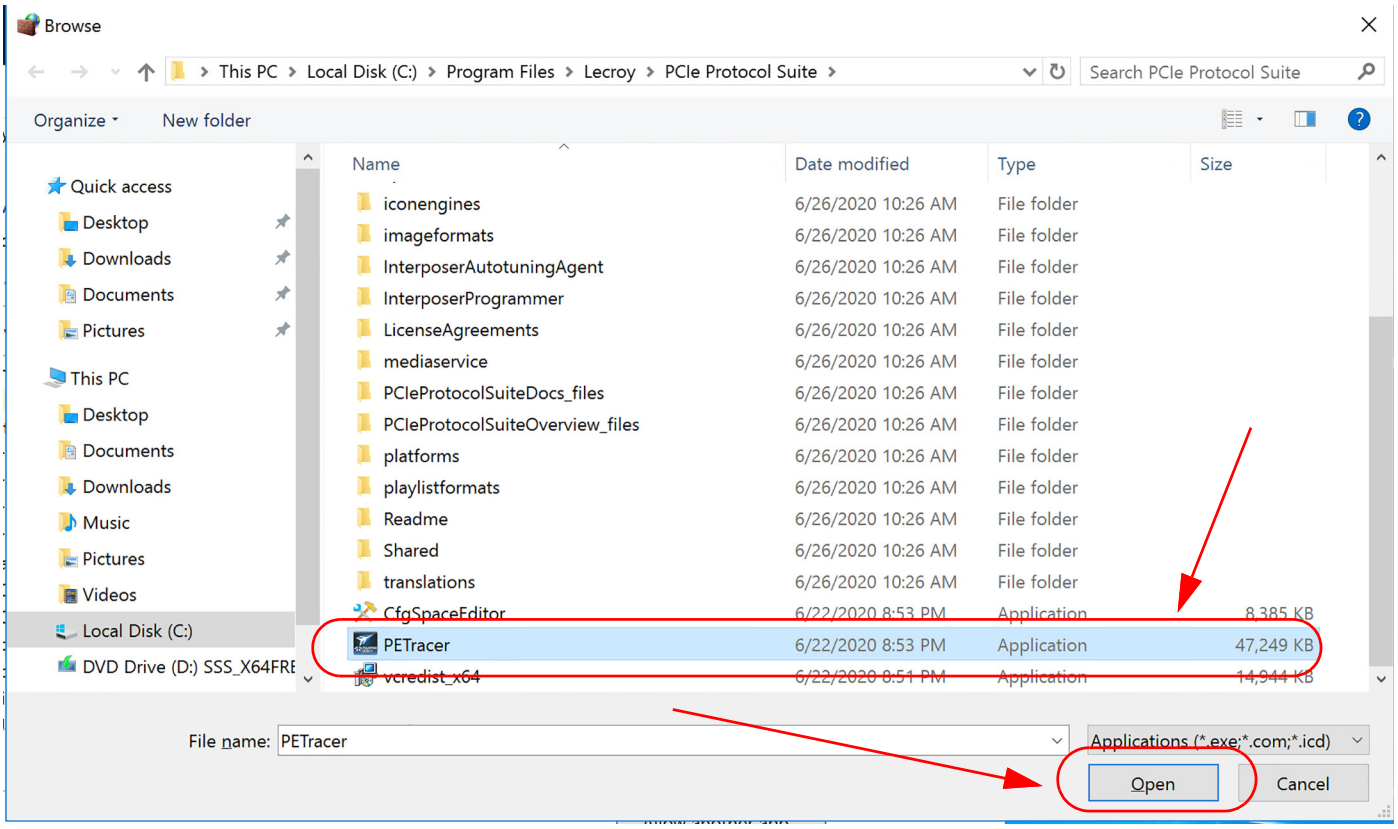


Figure 3.7: Windows Server 2016/2019: Browse to Find Application -> PCIe Protocol Analysis Application

8. Select the PCIe Protocol Analysis executable file (with the .exe extension) and click on “Open”.

9. If necessary, select the Teledyne LeCroy PCIe Protocol Analysis you want to add. Then click on “ADD”, this will add the Teledyne LeCroy PCIe Protocol Analysis to the Apps allowed through the Firewall. See Figure 3.8.

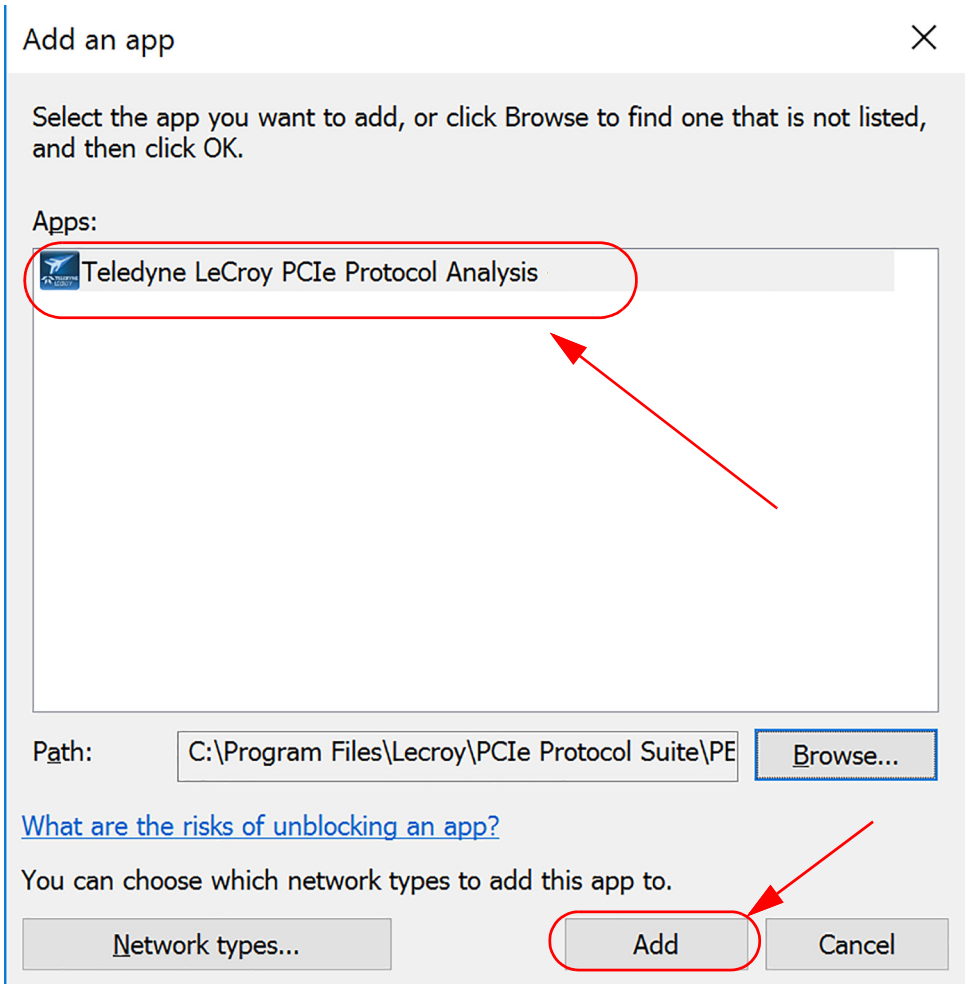


Figure 3.8: Windows Server 2016/2019: Add an Application to the Firewall Exceptions

10. After the Application has been added, you can see it in the “Allow apps to communicate through Windows Firewall” screen. See Figure 3.9.

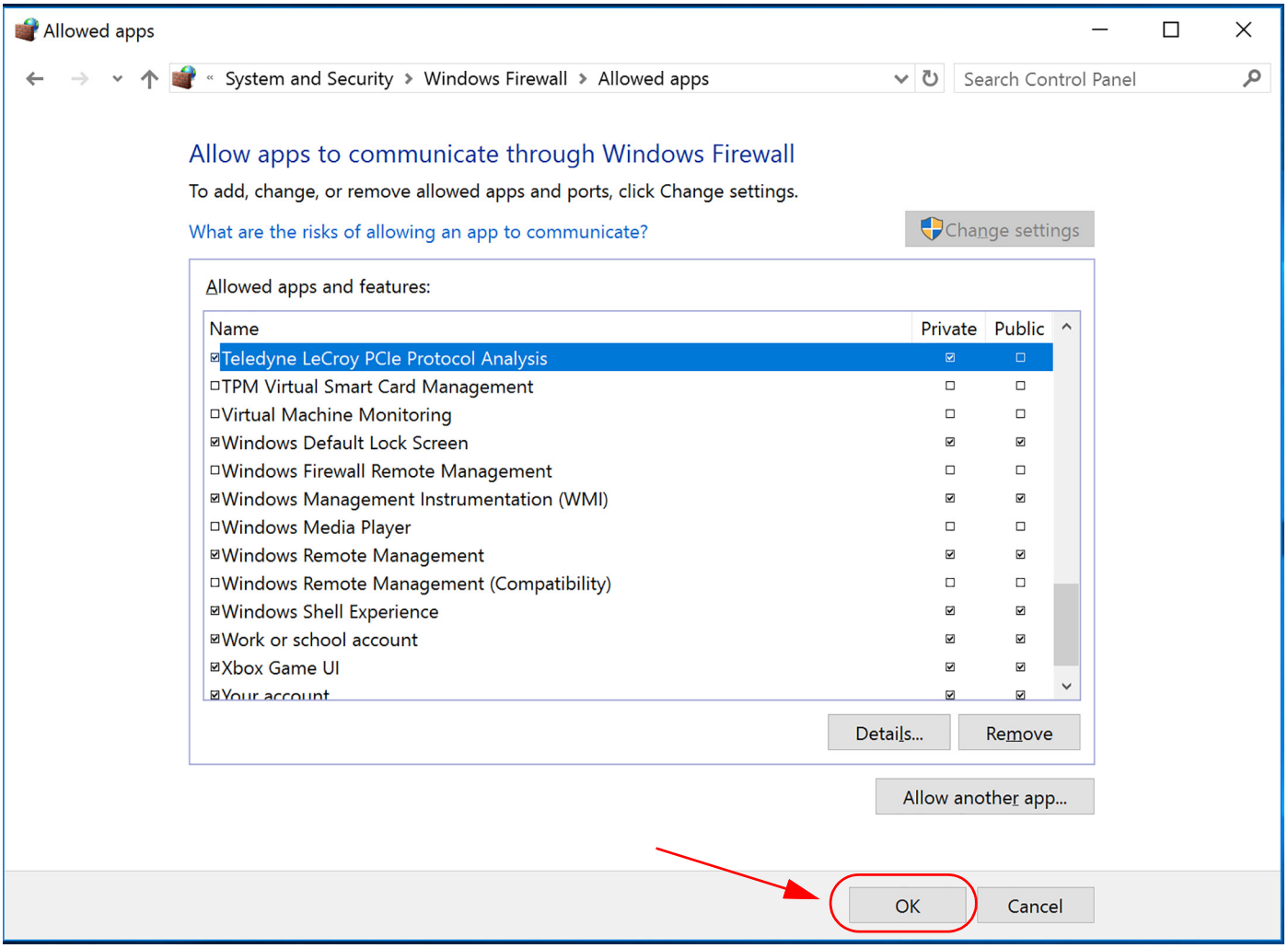


Figure 3.9: Windows Server 2016/2019: Add Teledyne LeCroy PCIe Protocol Analysis to Allowed Applications

Click “**OK**” and you’re done with updating the Firewall.

3.1.3 Launching the PCIe Protocol Analysis

To start the application, launch the PCIe Protocol Analysis program from the Start menu:
Start > All Apps > LeCroy > PCIe Protocol Analysis

Note: This path is correct for Windows 10. The path to start the PCIe Protocol Analysis may be slightly different in other versions of Windows.

Note: The images shown in this chapter for installing the software and configuring the system use the T3-16 as an example but all analyzers in the Summit family perform similarly and follow the same flow. The dialog boxes and menus that pop up during installation will vary depending on the analyzer being used.

The PCIe Protocol Analysis program displays below. See Figure 3.10

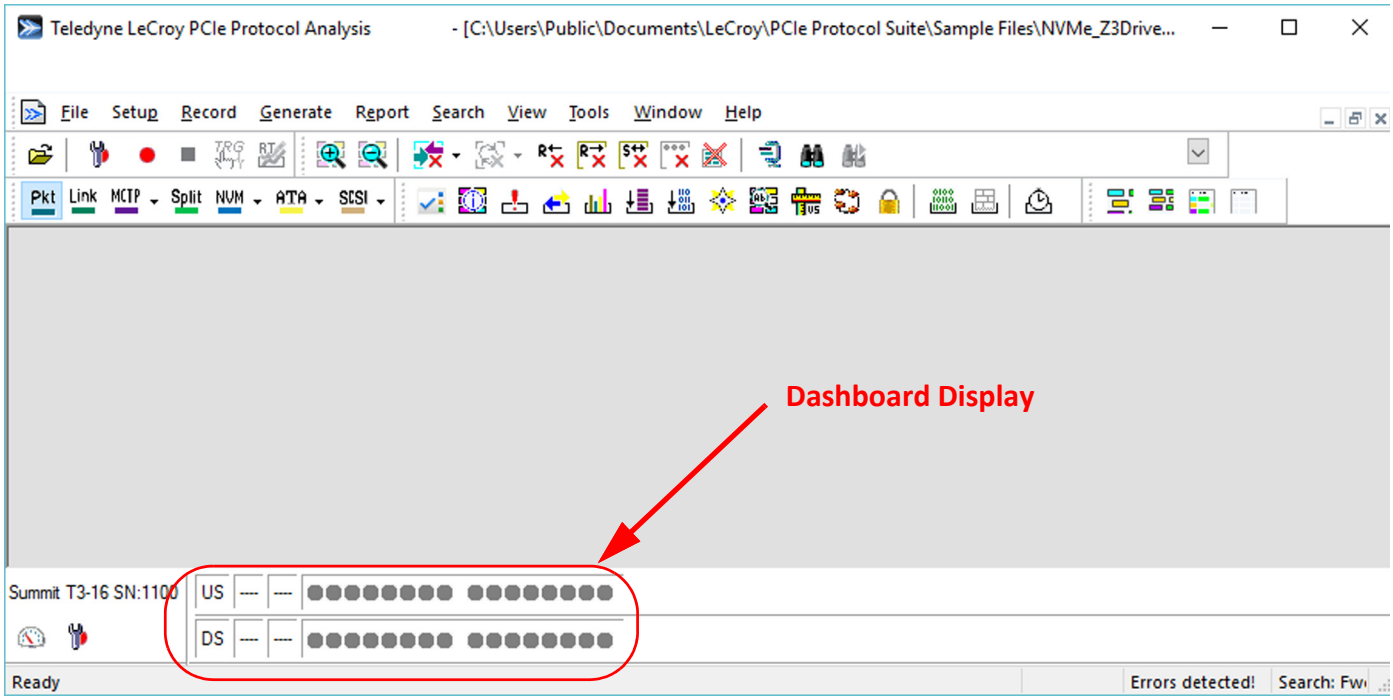


Figure 3.10: Teledyne LeCroy PCIe Protocol Analysis Application with Summit T3-16 Analyzer

Note: The software may be used with or without the Analyzer. When used without an Analyzer attached to the computer, the program functions as a CATC Trace Viewer to view, analyze and print captured traffic.

Note: The Dashboard display varies with the Model of the Summit Analyzer you are installing.

3.1.4 Setting Up a Summit Analyzer using a USB Connection

To set up the Analyzer using a USB connection:

1. Connect the Analyzer to a 100-volt to 240-volt, 50 Hz to 60 Hz, 120 W power outlet using the provided power cord.
2. Connect the USB port to a USB port on the host machine using a USB cable.

Note: To connect using Ethernet, see "Setting Up a Summit Analyzer using an Ethernet Connection" on page 79.

3. Turn on the front power switch.

Note: At power-on, the Analyzer initializes itself in approximately five seconds and performs an exhaustive self-diagnostic that lasts about forty seconds. The results are reflected by messages on the Summit T3- 16 and T3-8 Analyzer LCD display. For the Summit T34, T28 and T24 Analyzers, the status of the unit is displayed on the front panel's LEDs. If the LCD display or front panel LEDs indicate failure, call Teledyne LeCroy Customer Support for assistance. See "How to Contact Teledyne LeCroy" on page 723.

4. Follow the Microsoft® Windows® on-screen Plug-and-Play instructions for the automatic installation of the Analyzer as a USB device on your analyzing host machine. (The required USB drivers are installed on your system by the PCIe Protocol Analysis installation.)
5. Click **Finish** when you see the message that says "Windows has finished installing the software that your new hardware requires" and the file has been installed in your host machine.

3.1.5 Setting Up a Summit Analyzer using an Ethernet Connection

Note: If your PC and the analyzer are both on the same subnet you should have no problem making a DHCP connection. If they are not, you may have to set appropriate subnet and gateway settings. Also, it is best if TCP ports 4000 to 4003 and UDP ports 4015 to 4017 are available on the network, but even if they are not you may be able to force a connection by checking the "Force add/connect attempt" box.

1. Connect the Analyzer to a 100-volt to 240-volt, 50 Hz to 60 Hz, 120 W power outlet using the provided power cord.
2. Connect the Summit T3-16, T3-8 or T34 Analyzer to the network. The Ethernet port is on the front of the Analyzer for the T3-16 and T3-8. The Ethernet port is on the rear panel of the T34.

Note: To connect using USB, see “Setting Up a Summit Analyzer using a USB Connection” on page 78.

3. Turn on the front power switch.

Note: At power-on, the Analyzer initializes itself in approximately five seconds and performs an exhaustive self-diagnostic that lasts about forty seconds. The results are reflected by messages on the Summit T3- 16 and T3-8 Analyzer LCD display. For the Summit T34 Analyzer, the status of the unit is displayed on the front panel’s LEDs. If the LCD display or front panel LEDs indicate failure, call Teledyne LeCroy Customer Support for assistance. See “How to Contact Teledyne LeCroy” on page 723.

4. After you have installed the PCIe Protocol Analysis application software, perform the following procedure to connect to a Summit Analyzer in the local network.

   Select the **Setup > All connected devices…** menu in the PCIe Protocol Analysis application to display the Analyzer Devices dialog.

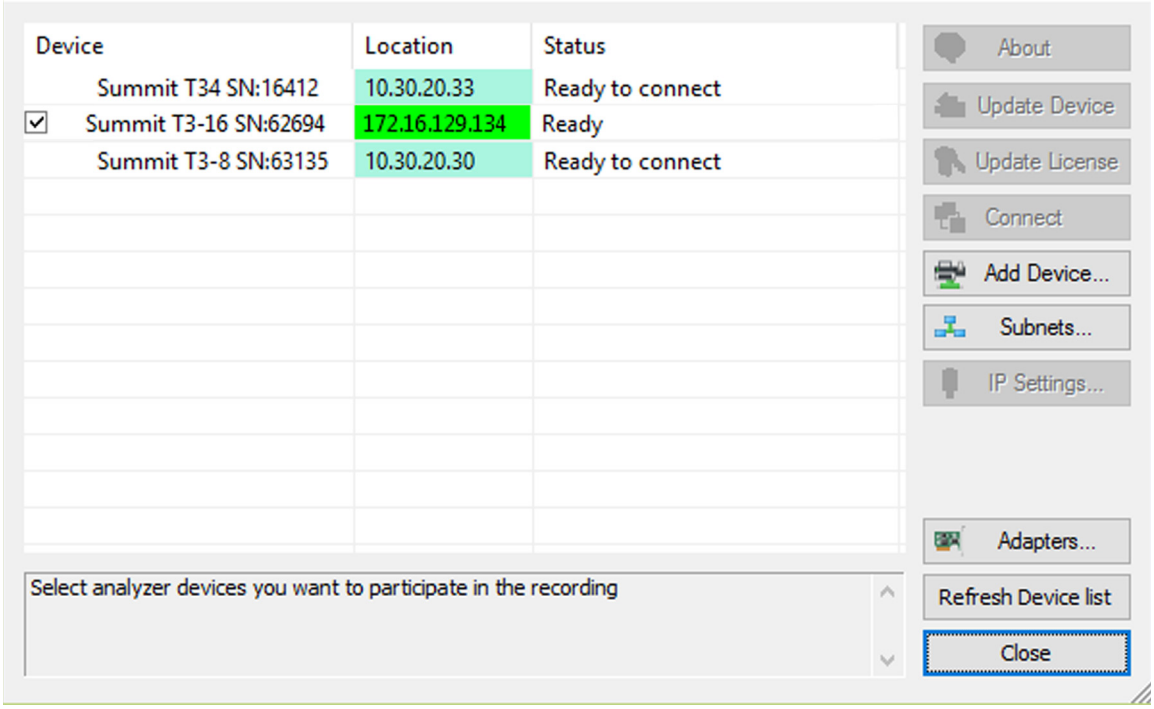


Figure 3.11: Analyzer Devices Dialog

The PCIe Protocol Analysis fills the list with devices that are connected over USB or discovered on the Ethernet network. The discovery mechanism works only within one network subnet. If a Summit is connected to the network on a different subnet, you can manually add the subnet to the list by clicking the **Add Device** button and specifying the IP address.

The Summit devices in the list are marked:

- **Locked**: Some other client on the network is already connected to that device
- **Ready to connect**: Available for connection

1. If a Summit device is marked Ready To Connect, you can select that device and press the **Connect** button to execute the connection procedure.

   After the connection is established, the application displays the Connection Properties dialog.

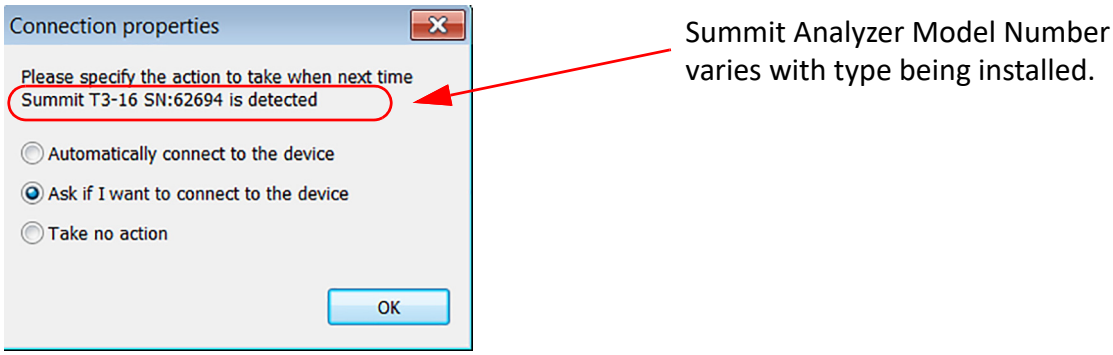


Figure 3.12: Connection Properties Dialog

2. Select an option:
   - **Automatically connect to the device**: When the application is started or when the named device is added to the network while the PCIe Protocol Analysis application is running on this computer, the PCIe Protocol Analysis application will try to connect to the named device.
   - **Ask if I want to connect to the device**: When the application is started or when the named device is added to the network while the PCIe Protocol Analysis application is running on this computer, the PCIe Protocol Analysis application will display a message box allowing you to connect to the named device.
   - **Take no action**: When you start the application or when you want to add the named device to the network while the PCIe Protocol Analysis application is running on this computer, you must connect manually to use the named device.

Note: When you close the application on this computer (or you perform a manual disconnect), the application disconnects from the device.

3. Press **OK** in the Connection Properties dialog.

   After you finish the connect procedure, the Summit device to which you have connected is marked as **Ready** and you can use it for recording (see Figure 3.13 on page 82).

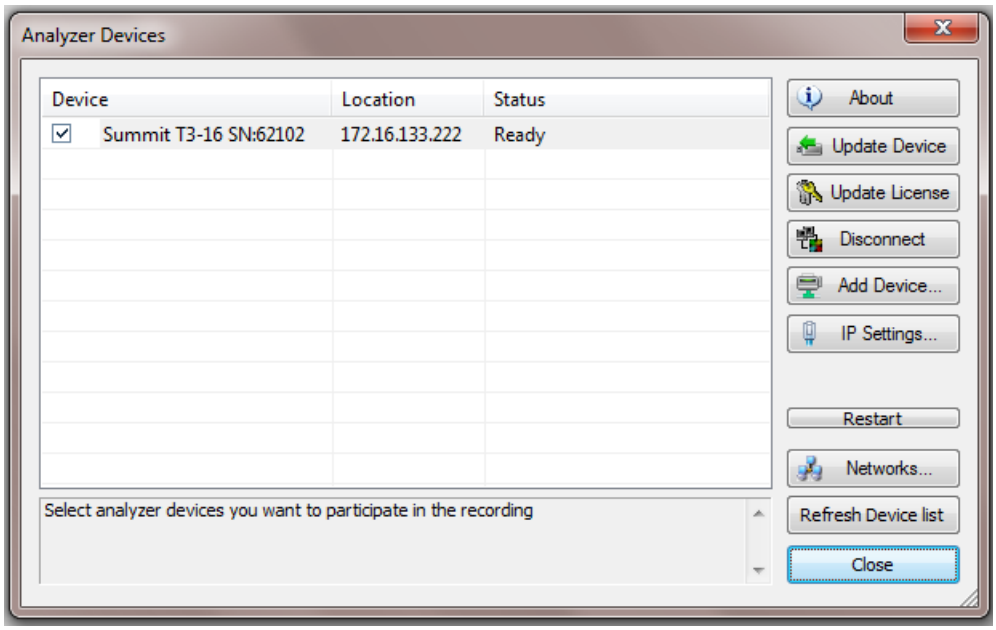


Figure 3.13: Analyzer Devices Dialog

Note: To disconnect from a device, display this dialog, select the device, and click the **Disconnect** button.

Note: As of version PCIe Protocol Analysis version 7.34, the software is able to access a Summit analyzer via VPN solutions that require explicit bindings to PPP adapters that they create.

3.1.6 Adding Devices Manually

You can locate and add a Summit Analyzer located in a Ethernet subnet using the Add Device button. Perform the following steps:

Click **Setup -> All Connected Devices -> Add Device ->** to display the Add Ethernet Attached Device dialog. The T3-16 Summit Analyzer is shown in below in the Dialog image but the process is similar for any Summit Analyzer. See Figure 3.27.

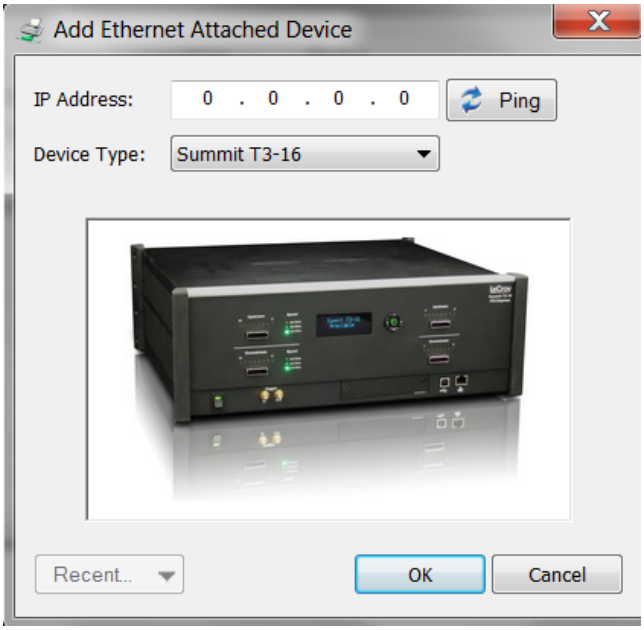


Figure 3.14: Manually Add Ethernet Attached Devices Dialog

Click the **Recent** button to display a list of recently added devices (up to 15) and quickly add a recently used device.

Click the **Ping** button to ping a device as a network node (prompting an error message if no response). Ping also allows PCIe Protocol Analysis to detect a device type before actually connecting to the device.

If the "Ping" feature discovers that the device is already connected and "locked" then it will inform the user and provide information about who locked the device.

Click **Setup -> All Connected Devices** to display the Analyzer Devices dialog.

If software fails to connect to a manually added device, a message displays notifying the user about the connection failure. The user is given the option to keep the failed device in the device list, in this case PCIe Protocol Analysis displays a "Failed to connect" status message in gray.

Square brackets for IP addresses are used for manually added devices to easily distinguish them from auto-discovered devices.

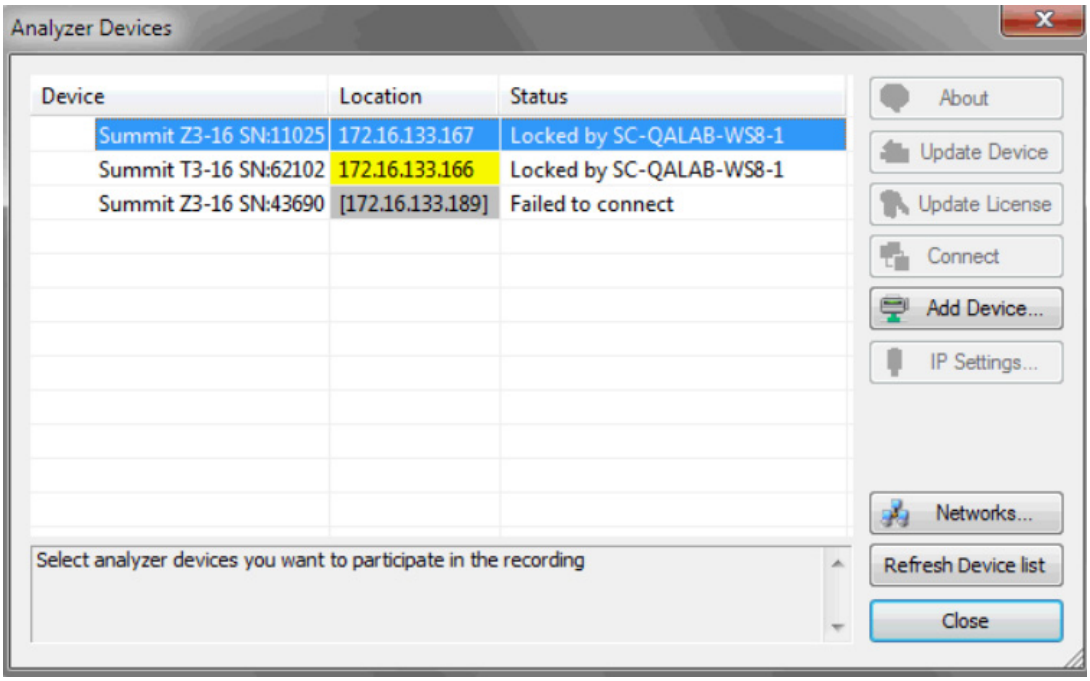


Figure 3.15: Add Ethernet Attached Devices Dialog

3.1.7 Adding a Summit T34 to an Ethernet Network

If you have a Summit T34 or any other Summit Analyzer and want to add it to an Ethernet Network but don't know it's IP address you can find out the IP address and add it to the Ethernet Network using either the "Help -> About" menu or using the USB connection (see "Using USB Connection to Discover IP Address" on page 87.

3.1.7.1 Using *Help -> About* Menu to Discover IP Address

Select the Help tab on the PCIe Protocol Analysis Main Toolbar (see Figure 3.16).

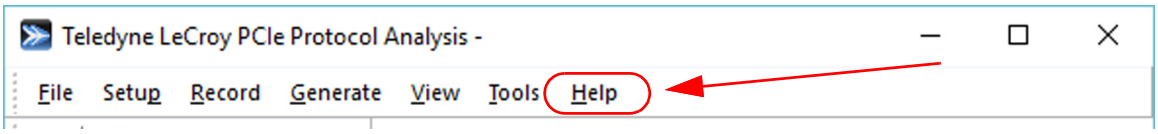


Figure 3.16: PCIe Protocol Analysis Toolbar

This will display the drop down ***Help*** menu with the following options:

- User Manual
- Display License Information...
- Register Product Online...
- Check for Updates...
- Tell Teledyne LeCroy
- Shortcut List
- About PCIe Protocol Analysis...

See Figure 3.17.

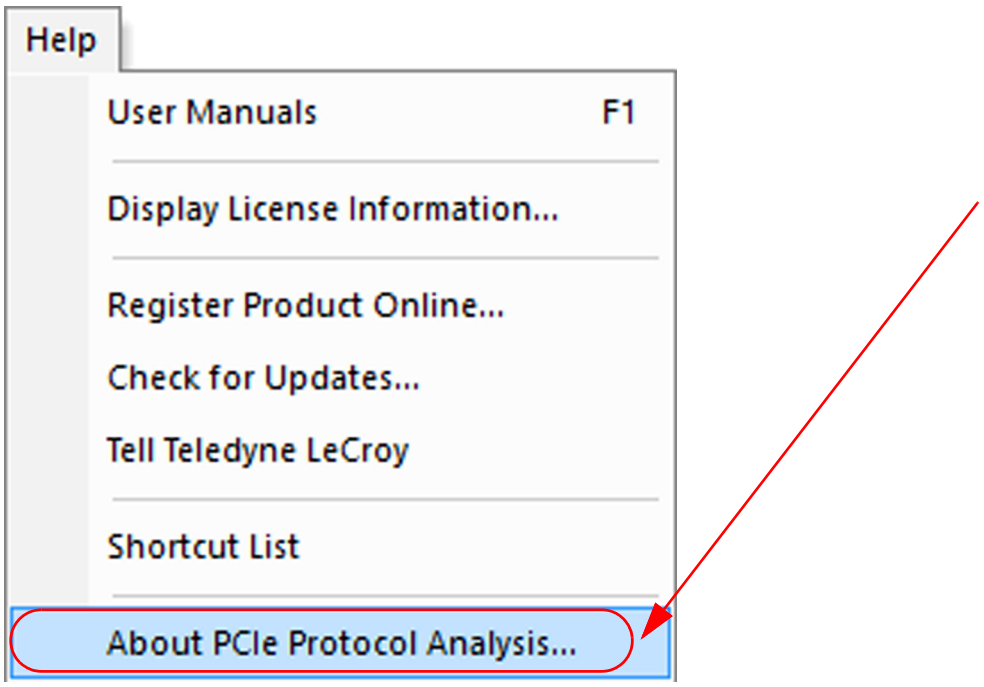


Figure 3.17: About -> Help Drop Down Menu

Select About PCIe Protocol Analysis Tab to discover the T34's IP address. See Figure 3.18.

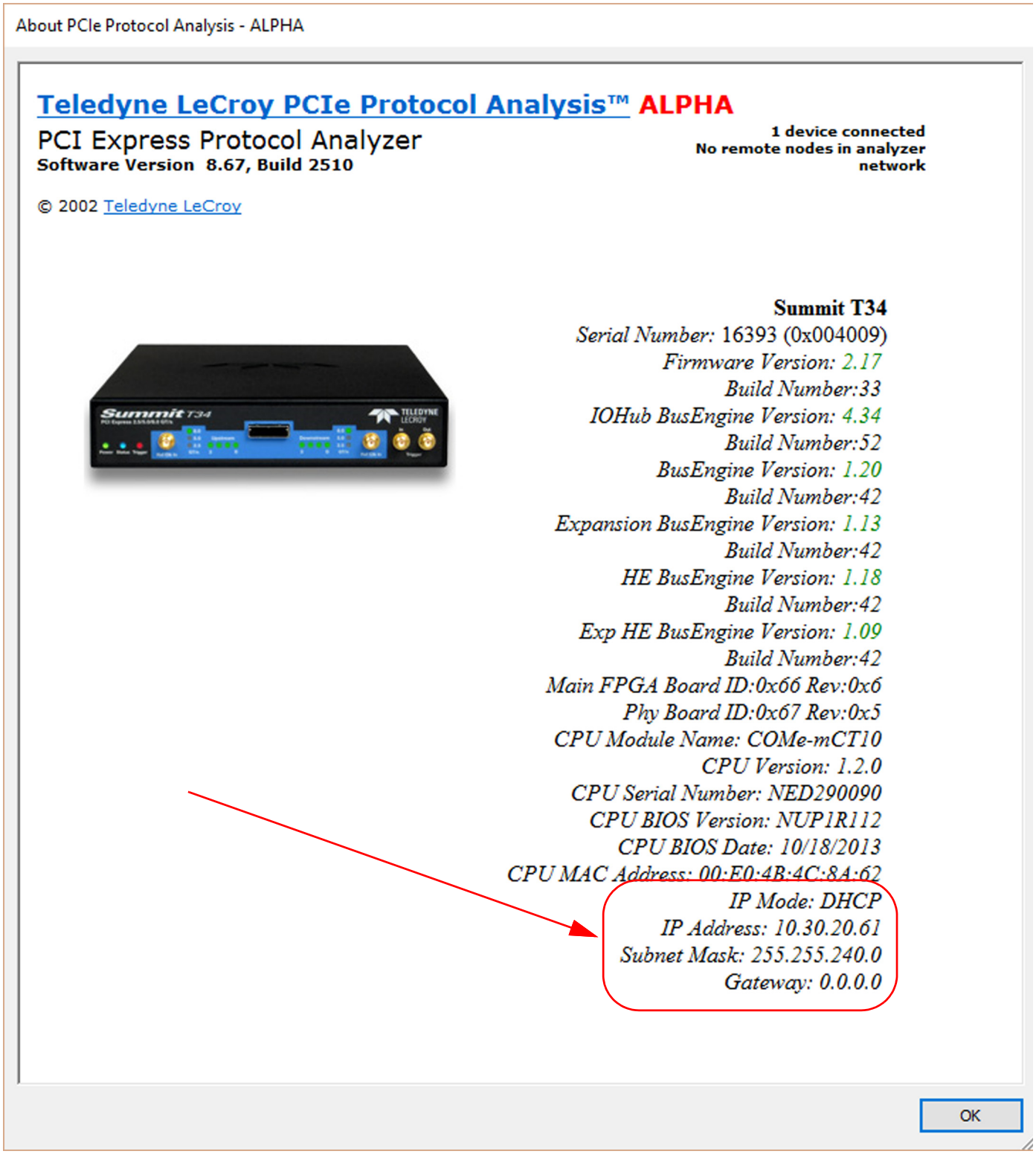


Figure 3.18: Information About T34 Including IP Address

The **About** menu shows you the IP Address, Subnet Mask and Gateway.

3.1.7.2 Using USB Connection to Discover IP Address

With the USB cable installed, start up the PCIe Protocol Analysis and select **Setup > All connected Devices.** See Figure 3.19.

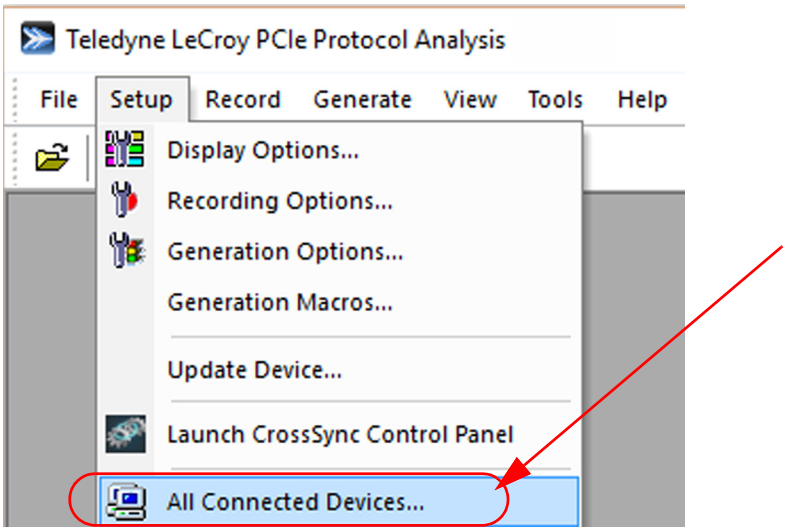


Figure 3.19: Setup > All Connected Devices

This will popup a dialog box showing all the connected devices on your network. See Figure 3.20.

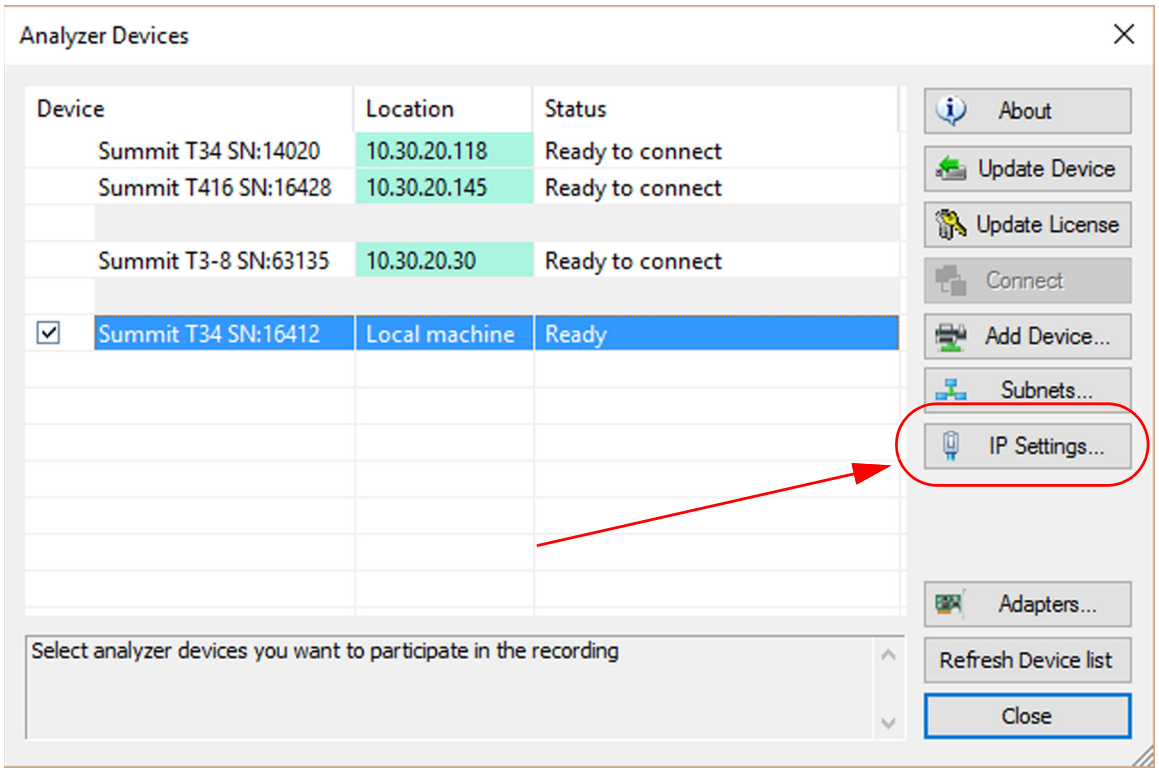


Figure 3.20: All Devices Connected on Your Network

To discover the IP address of the local T34 (attached via the USB cable to your Summit T34), select the IP Settings tab. This will popup the Device Settings dialog box. See Figure 3.21.

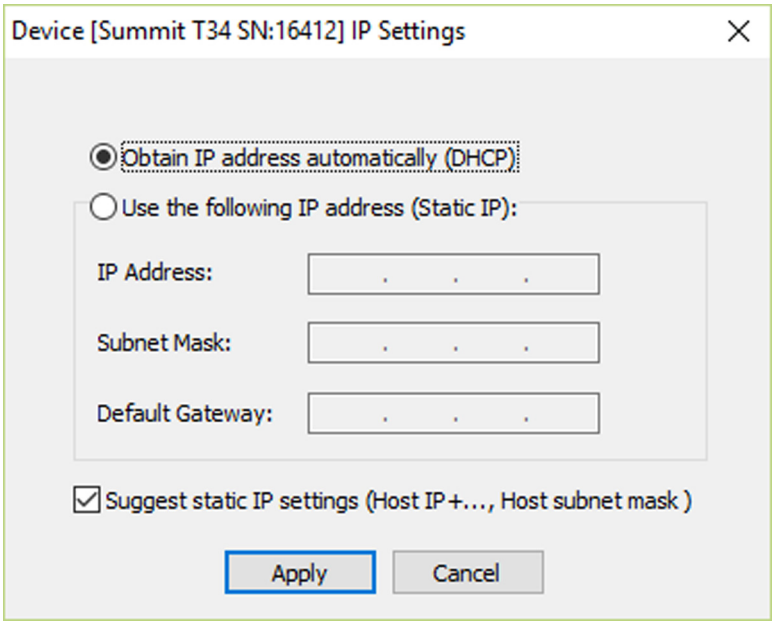


Figure 3.21: Device IP Settings

From this dialog box you can either:

- Obtain an IP address automatically (DCHP)
- Use the following IP address (Static IP)
- Suggest Static IP Settings

If you choose the DCHP option the following dialog box will popup (see Figure 3.22).

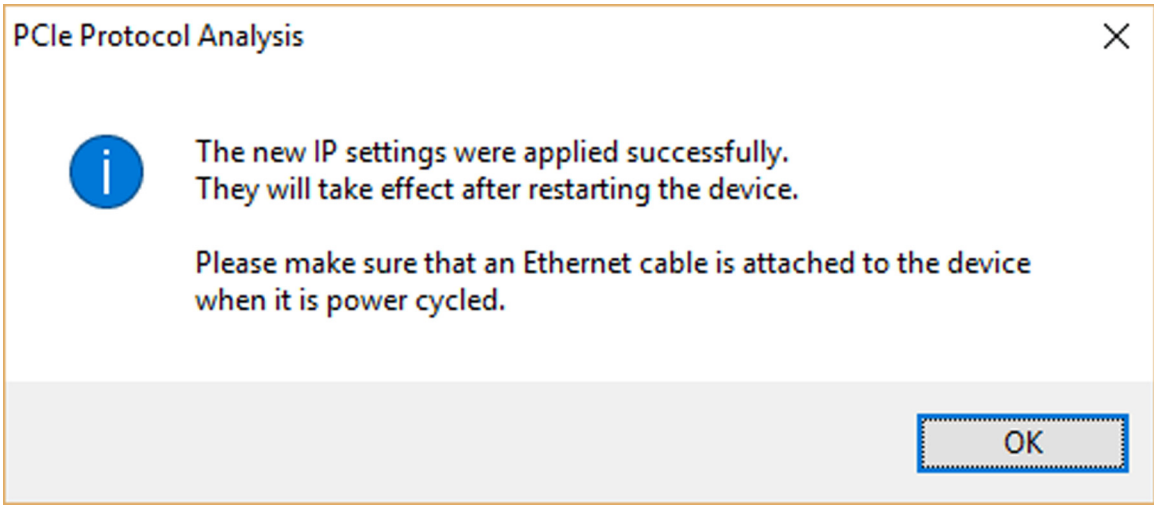


Figure 3.22: Use DCHP to Set IP Address

If you had chosen to use the Static IP address the following Dialog Box would popup (see Figure 3.23.

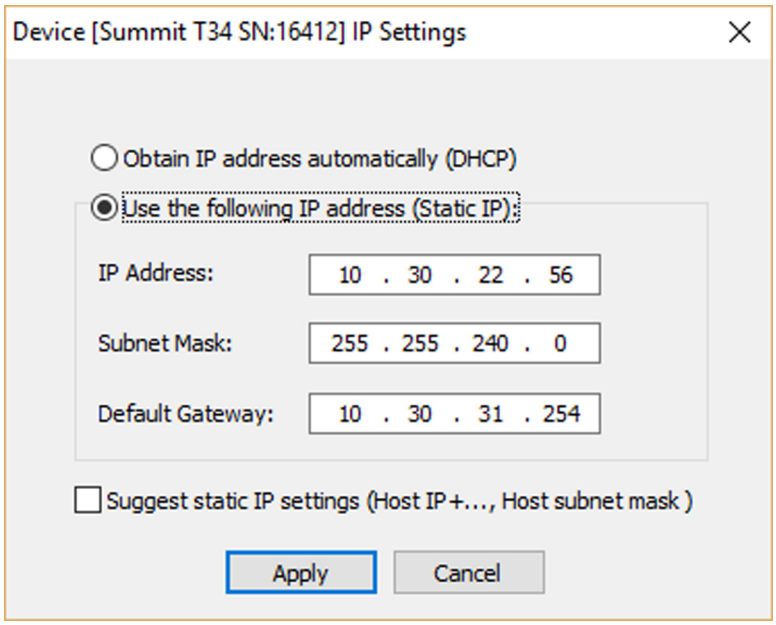


Figure 3.23: Use Static IP Address

If you had chosen the Suggest static IP settings the following dialog box would popup (see Figure 3.24).

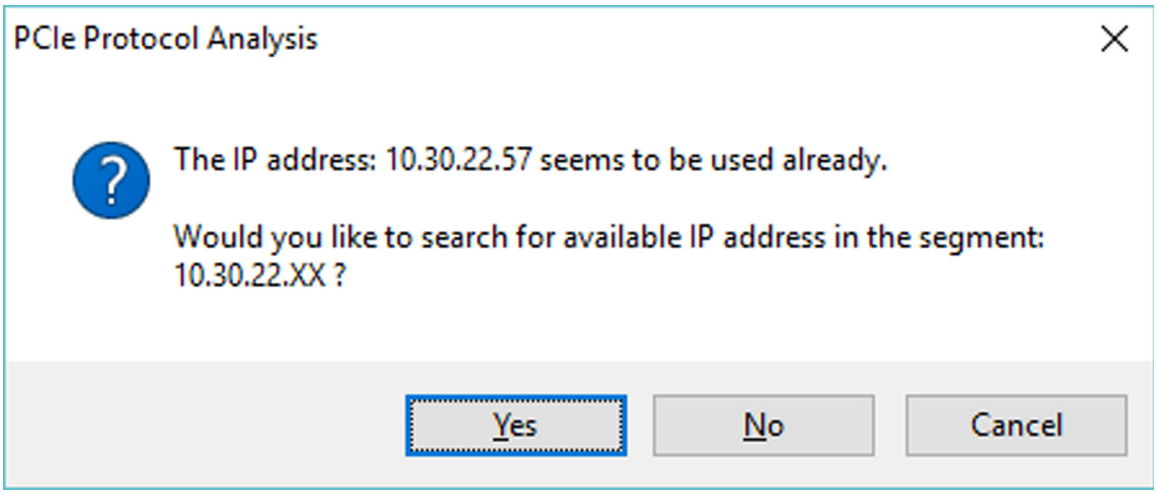


Figure 3.24: Suggest Static IP Settings

Select "Yes" and the system will select an unused IP address.

The the following dialog box will popup. See Figure 3.25.

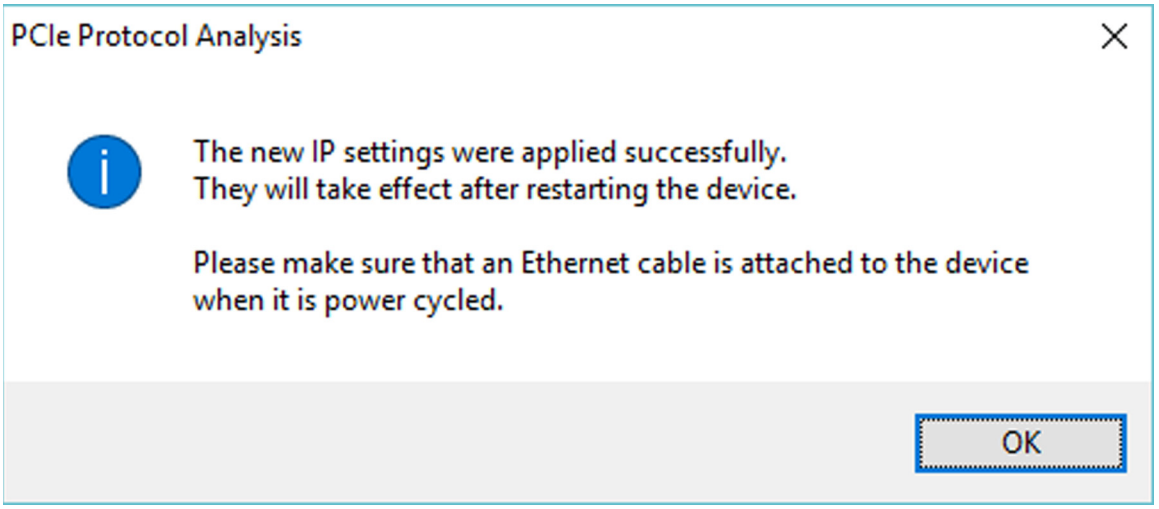


Figure 3.25: New IP Settings Applied

Now you should attach the Ethernet cable, disconnect the USB cable and cycle the power on the Summit T34.

After the T34 re-initializes and the Status LED goes from OFF to Green to Blue, restart the PCIe Protocol Analysis and select **Setup > All Connected Devices.**

Now the Summit T34 has an IP address and is Ready to Connect. See Figure 3.26.

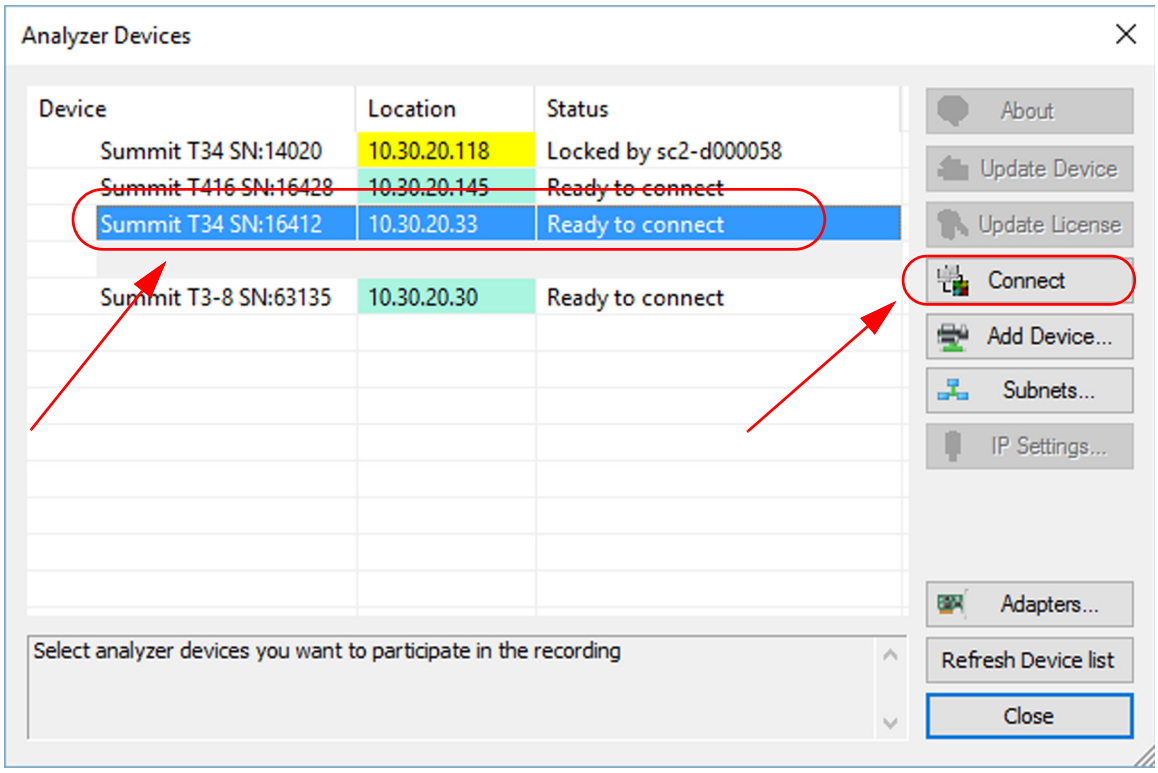


Figure 3.26: Analyzer Devices: T34 Showing IP Address

Select the Connect tab and you are ready to start capturing data traffic with the Summit T34.

3.2 Interposers and Probes

The Summit Analyzers work with a wide variety of Interposers and Probes. Some of them are listed below. Please refer to the *Interposers and Probes for Teledyne LeCroy PCI Express Systems datasheet* at www.teledynelecroy.com for a comprehensive list.

3.2.1 Interposers

- **Gen3 Interposer**: The Gen3 Interposer is designed for use with the Summit T3-16, Summit T3-8 and Summit T34 Analyzers. It supports link widths from x1 to x16 at data rates of 2.5 GT/s, 5.0 GT/s, and 8.0 GT/s. For link widths up to x8, one iPass Y-cable is required. For x16 applications, two iPass Y-cables are required. See Gen3 Interposer Quick Start Guide for more details.
- **Gen2 Active Interposer**: The Gen2 Active Interposer is designed for use with the Summit T3-16, T3-8, T34, T28 and T24 Analyzers. It supports link widths from x1 to x16 at data rates of 2.5 GT/s or 5.0 GT/s. For link widths up to x8, one iPass Y-cable is required. For x16 applications, two iPass Y-cables are required. See Gen2 Active Interposer Quick Start Guide for more details.
- **Gen2 Passive Interposer**: The Gen2 Passive Interposer is designed for use with the Summit T3-16, T3-8, T34 T28 and T24 Analyzers. It supports link widths from x1 to x16 at data rates of 2.5 GT/s or 5.0 GT/s. For link widths up to x8, one iPass Y-cable is required. For x16 applications, two iPass Y-cables are required.

3.2.2 Probes

- **Gen3 MidBus Probe**: The Gen3 MidBus Probe is designed for use with the Summit T3-16, T3-8 and T34 Analyzers. It supports link widths from x1 to x16 at data rates of 2.5 GT/s, 5.0 GT/s, and 8.0 GT/s. See PCI Express 3.0 Mid-Bus Probe Installation and Usage Manual for more details.

Note: For x16 links, two MidBus probes are required.

- **Gen3 Multi-lead Probe:** The Gen3 Multi-lead Probe is designed for use with the Summit T3-16, T3-8 and T34 Analyzers. It supports link widths from x1 to x16 at data rates of 2.5 GT/s, 5.0 GT/s, and 8.0 GT/s. See Gen3 Multi-lead Probe User Manual for details.
- **Gen2 MidBus Probe**: The Gen2 MidBus Probe is designed for use with the Summit T3-16, T3-8, T34 T28 and T24 Analyzers. It supports link widths from x1 to x16 at data rates of 2.5 GT/s or 5.0 GT/s. See Gen2 Midbus Probe Quick Start Guide for details.

Note: For x16 links, two MidBus probes are required.

- **Gen2 Multi-lead Probe**: The Gen2 Multi-lead Probe is designed for use with the Summit T3-16, T3-8, T34 T28 and T24 Analyzers. The probe consists of 1 to 4 probe pods, which are connected to the analyzer using either iPass Y-Cables (for x1 and x4) or straight x4-to-x8 iPass cables (for x8 and x16). Each probe pod supports up to 8 Flex Tips, with each Flex Tip connected via two coax cables. See Gen2 Multi-lead Probe User Manual for details.

The following sections describe how to set up interposer and probe systems.

3.3 Interposers and Probes for Use with Summit T3-16 Analyzer

The following sections show a Summit T3-16 Analyzer used with various interposers and probes.

3.3.1 Use of Interposers with Summit T3-16

The following section describes how to connect interposers.

3.3.1.1 Gen3 Interposer

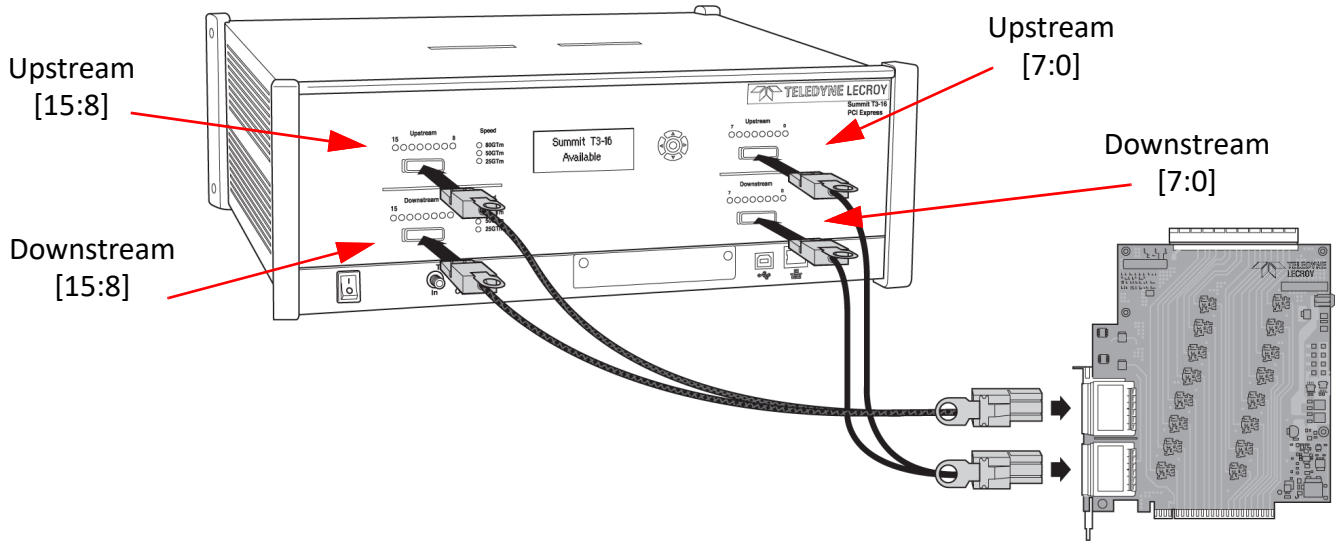


Figure 3.27: Connecting the Summit T3-16 Analyzer to the Device Under Test Using a Gen3 Interposer

Summit T3-16 Components

Summit T3-16 components used in the installation are:

- **iPass Y-Cable**: The cable supports eight lanes from two directions. Side A of the probe cable connects to the Upstream port on the Analyzer (on the top right in the drawing above, see Figure 3.27), and Side B of the probe cable connects to the Downstream port (on the bottom right).
  Note: x16 recordings require two cables.
- **x16 Slot Gen3 Interposer**: The slot Interposer provides the point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer.

Installing the Gen3 Interposer

To install the Interposer, perform the following steps:

1. Insert the gold male connector on the Interposer probe into a x16 PCI Express slot in the motherboard. Interposers are available in x1, x4, x8, and x16 versions.

2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to the host machine's enclosure.

Connecting the Probe Data Cable

x8 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the Interposer card at [7:0]. Connect Side A of the probe cable to the Upstream [7:0] port on the Analyzer, and connect Side B of the probe cable to the Downstream [7:0] port.

x16 recordings require two cables. Connect the second probe data cable to the Interposer card at [15:8]. Connect Side A of the second probe cable to the Upstream [15:8] port on the Analyzer, and connect Side B of the second probe cable to the Downstream [15:8] port.

3.3.1.2 Gen2 Active Interposer

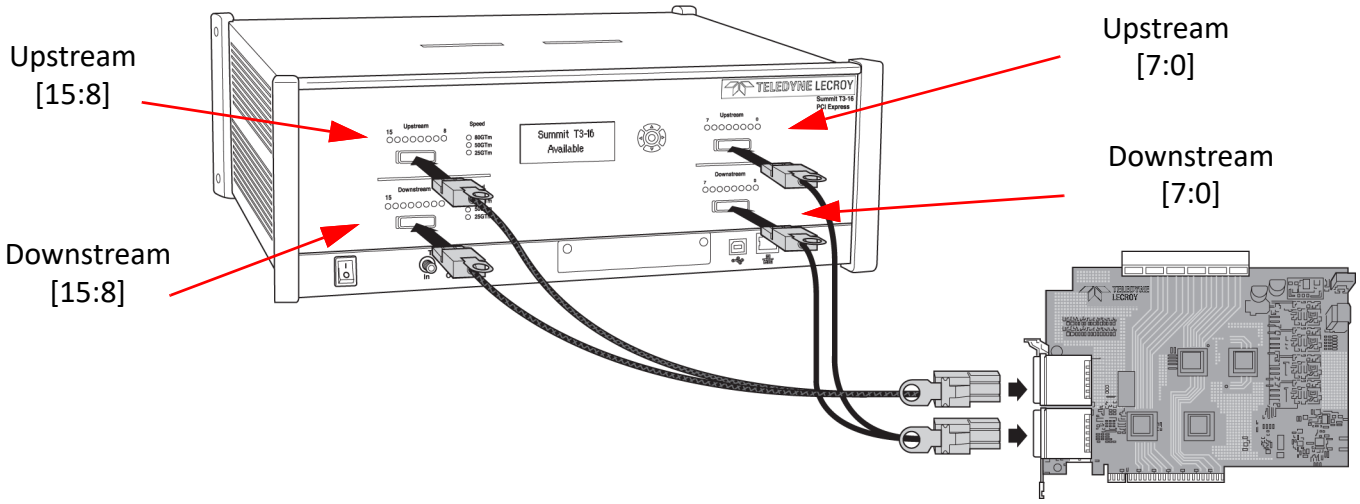


Figure 3.28: Connecting the Summit T3-16 Analyzer to the Device Under Test Using a Gen2 Active Interposer

Summit T3-16 Components

Summit T3-16 components used in the installation are:

- **iPass Y-Cable**: The cable supports eight lanes from two directions. Side A of the probe cable connects to the Upstream port on the Analyzer (on the top right in the drawing above see Figure 3.28), and Side B of the probe cable connects to the Downstream port (on the bottom right).
  Note: x16 recordings require two cables.
- **x16 Slot Gen2 Active Interposer**: The slot Interposer provides the point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer.

Note: Edge reducers are required for link widths less than x16.

Installing the Gen2 Active Interposer

To install the Interposer, perform the following steps.

1. Insert the gold male connector on the Interposer probe into a x16 PCI Express slot in the motherboard. Use edge adapters for x1, x4, and x8 slots.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to the host machine's enclosure. If you are working with a motherboard that is not in the host machine's enclosure, you may prefer to remove the metal face plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer

Connecting the Probe Data Cable

x8 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the Interposer card at [7:0]. Connect Side A of the probe cable to the Upstream [7:0] port on the Analyzer, and connect Side B of the probe cable to the Downstream [7:0] port.

x16 recordings require two cables. Connect the second probe data cable to the Interposer card at [15:8]. Connect Side A of the second probe cable to the Upstream [15:8] port on the Analyzer, and connect Side B of the second probe cable to the Downstream [15:8] port.

Power On Analyzer and then DUT

Important: Power on the Analyzer before you power on the DUT.

1. Power on the Summit T3-16 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Analysis on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.3.1.3 Gen2 Passive Interposer

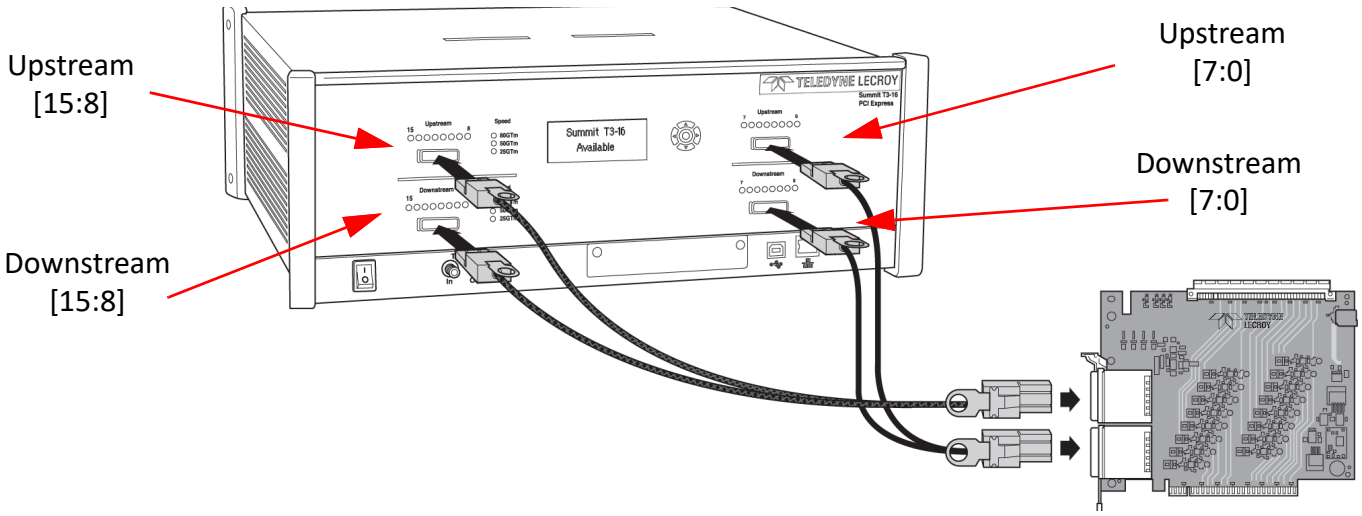


Figure 3.29: Connecting the Summit T3-16 Analyzer to the Device Under Test Using a Gen2 Passive Interposer

Summit T3-16 Components

Summit T3-16 components used in the installation are:

- **iPass Y-Cable**: The cable supports eight lanes from two directions. Side A of the probe cable connects to the Upstream port on the Analyzer (on the top right in the drawing above), and Side B of the probe cable connects to the Downstream port (on the bottom right). See Figure 3.29 on page 95.
  Note: x16 recordings require two cables.
- **x16 Slot Gen2 Passive Interposer**: The slot Interposer provides the point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer.

Installing the Gen2 Passive Interposer

To install the Interposer, perform the following steps:

1. Insert the gold male connector on the Interposer probe into a x16 PCI Express slot in the motherboard. Use edge adapters for x1, x4, and x8 slots.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to the host machine's enclosure. If you are working with a motherboard that is not in the host machine's enclosure, you may prefer to remove the metal face plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer.

Connecting the Probe Data Cable

x8 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the Interposer card at [7:0]. Connect Side A of the probe cable to the Upstream [7:0] port on the Analyzer, and connect Side B of the probe cable to the Downstream [7:0] port.

x16 recordings require two cables. Connect the second probe data cable to the Interposer card at [15:8]. Connect Side A of the second probe cable to the Upstream [15:8] port on the Analyzer, and connect Side B of the second probe cable to the Downstream [15:8] port.

Power On Analyzer and then DUT

1. Power on the Summit T3-16 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Analysis on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.3.2 Using Probes with the Summit T3-16

The following description shows a Summit T3-16 Analyzer used with various probes.

3.3.2.1 Gen3 MidBus Probe

Components

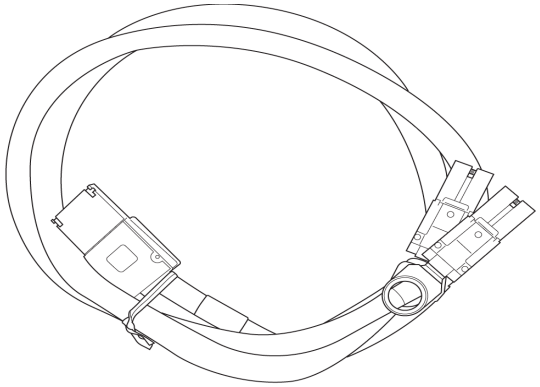


Figure 3.30: Single iPass Y-cable (two needed for x16 recording)

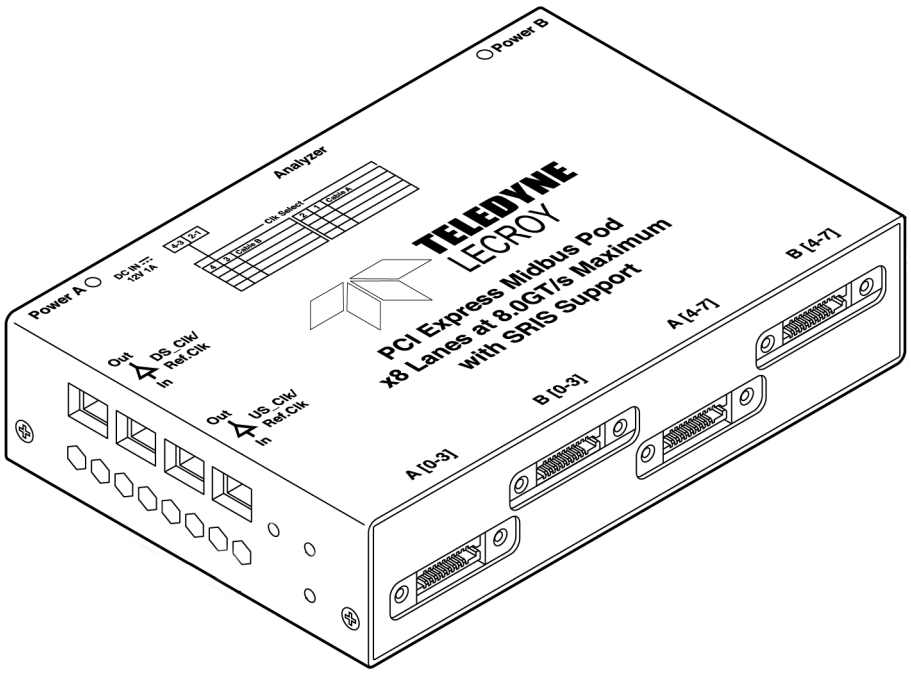


Figure 3.31: Gen3 MidBus Probe Pod

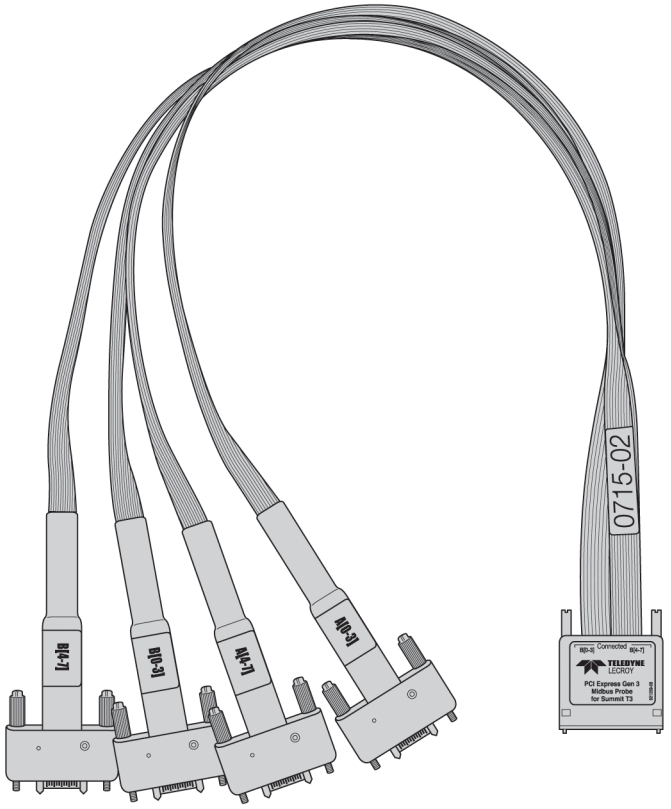


Figure 3.32: Full-size Gen3 Mid-bus Probe Cable and Header Assembly

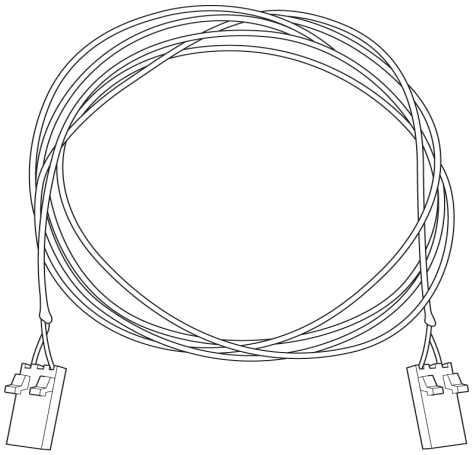


Figure 3.33: Single Clock Cable (one per pod)

Connections Overview for Gen3 MidBus Probe

Use a 1-pod or 2-pod setup depending on the link width of the recording:

- For x16 recordings, use the 2-pod setup.
- For all other link width recordings, use a one-pod setup.

Use the iPass Y-cables to connect the probe data connectors on the Analyzer to the MidBus pod(s).

On the other side of the pod, connect the MidBus probe assembly (see Figure 3.34 below and Figure 3.35 on page 100).

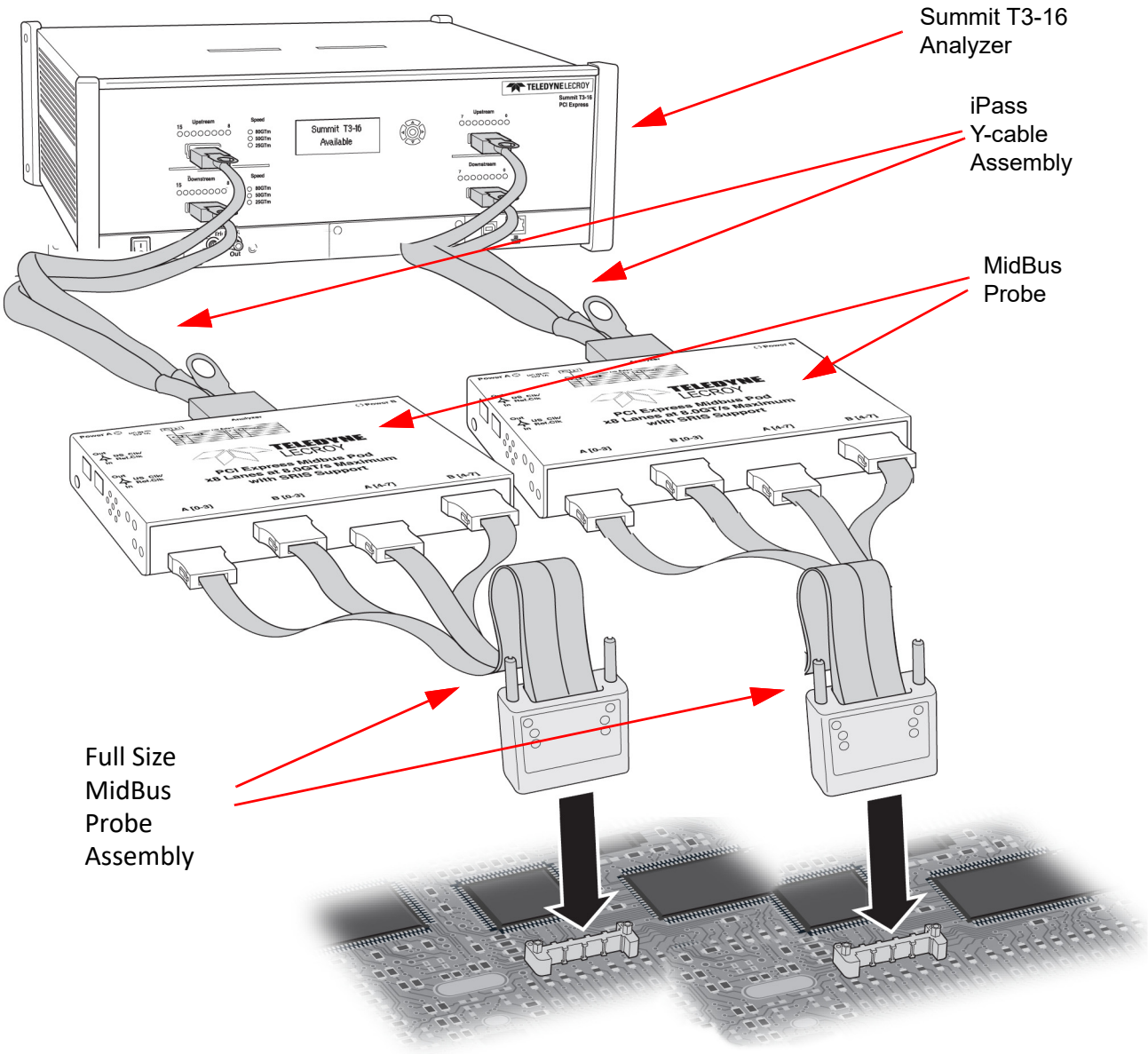


Figure 3.34: Connecting Gen3 MidBus Probe Connections

Connect the header on the MidBus probe assembly to the MidBus footprint on the System Under Test (host platform or root complex under test). The following picture shows two midbus footprints, with one connected to the MidBus probe assembly.

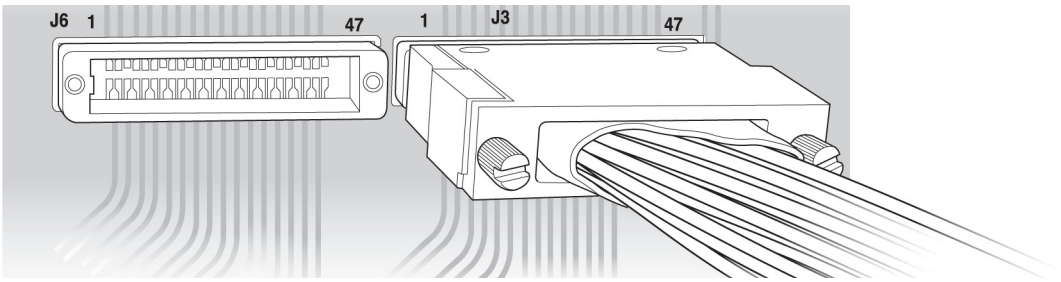


Figure 3.35: Connect Gen3 MidBus Full Size Probes to MidBus Full Size Footprints

Connection Procedure

To connect the Summit T3-16 to the System Under Test (host platform or root complex under test:

1. Connect the MidBus pods to the Analyzer using the iPass Y-cables.
2. Connect the MidBus probe assemblies to the MidBus pods.
3. Connect the MidBus probe assemblies to the MidBus footprints on the system under test.
4. Connect external reference clock signal to Mid-Bus External Clock In on Mid-Bus probe pod, using external reference clock cable. For x16, you need to chain the pods.

3.3.2.2 Gen3 Multi-lead Probe for x1 and x4

Components

- ❑ 1 iPass Y-cable for x1 and x4 (see Figure 3.30 on page 97).
- ❑ Gen3 Multi-lead Probe Pod for x1 and x4 (see Figure 3.36).

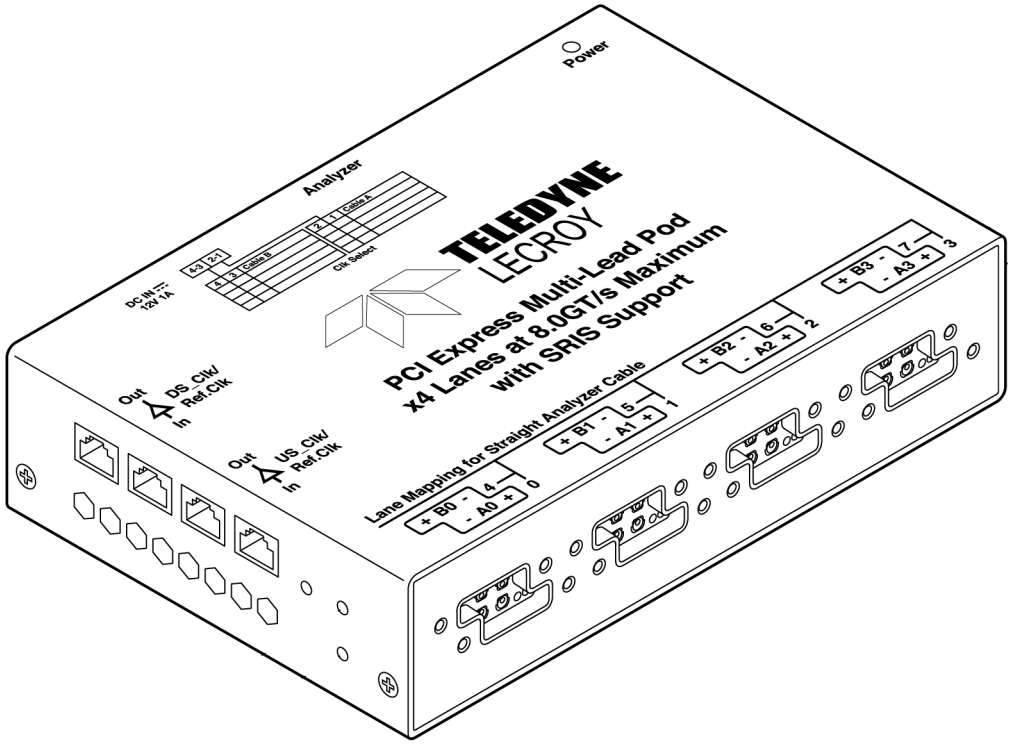


Figure 3.36: Gen3 Multi-lead Probe Pod

- ❑ 1 Clock Cable (see Figure 3.33 on page 98).
- ❑ Gen3 Multi-lead Probe Cable and Probe Tip (see Figure 3.37).

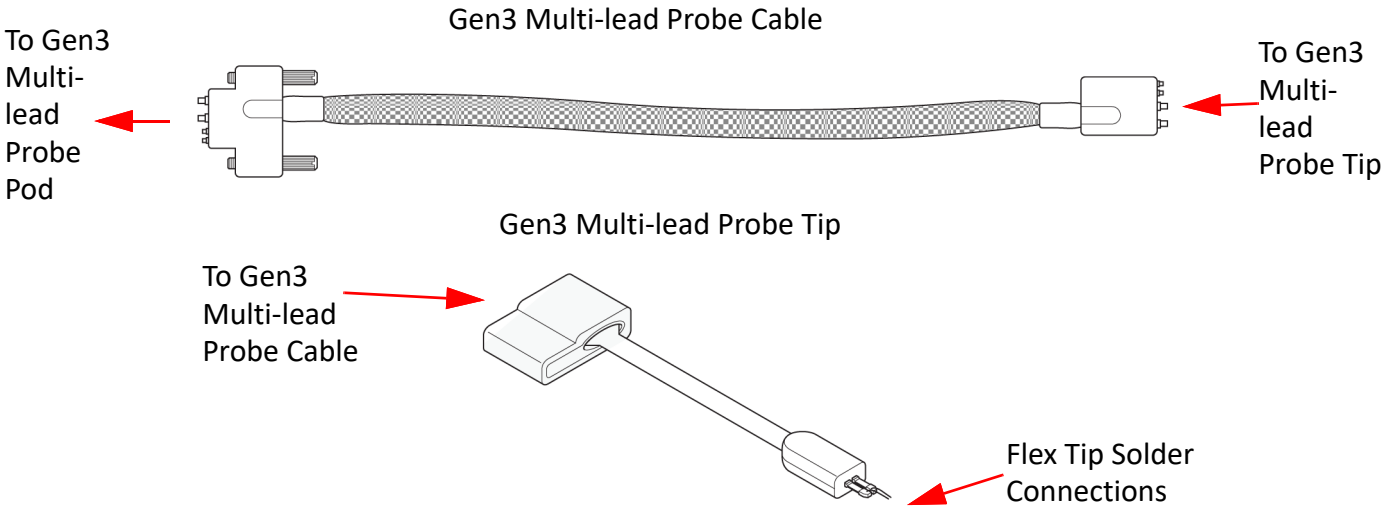


Figure 3.37: Gen3 Multi-lead Probe Cable and Probe Tip

Connections Overview for Gen3 Multi-lead Probe for x1 to x4

Use a 1-pod setup. See Figure 3.38 below.

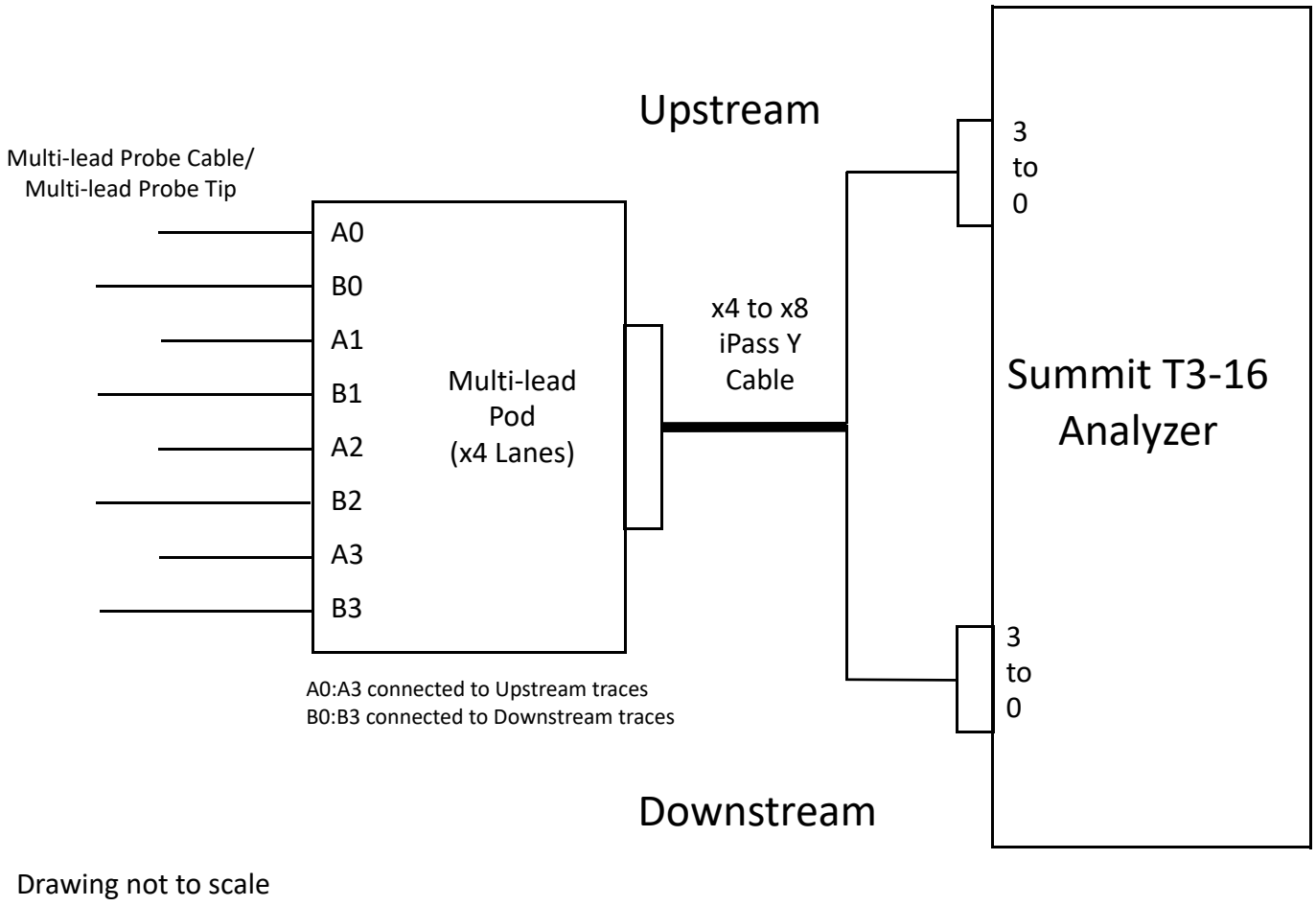
For x1 or x4, use the iPass Y-cable to connect the probe data connectors on the Analyzer to the pod(s).

On the other side of the pod, connect the Gen3 Multi-lead Probe Cable and Probe Tips.

Connection Procedure

To connect Summit T3-16 to the System Under Test (host platform or root complex under test):

1. Connect the pods to the Analyzer using the iPass Y-cable cables.
2. Connect the Gen3 Multi-lead Probe Cable and Probe Tip cables to the pods.
3. Connect the lead tips to the system under test by soldering to the trace.



Drawing not to scale

Figure 3.38: Interconnect Diagram for Summit T3-16 using One x4 Multi-lead Pod

3.3.2.3 Gen3 Multi-lead Probe for x8 and x16

Components

- ❑ 2 iPass Straight cables for x8 and 4 iPass Straight cables for x16 (see Figure 3.39)

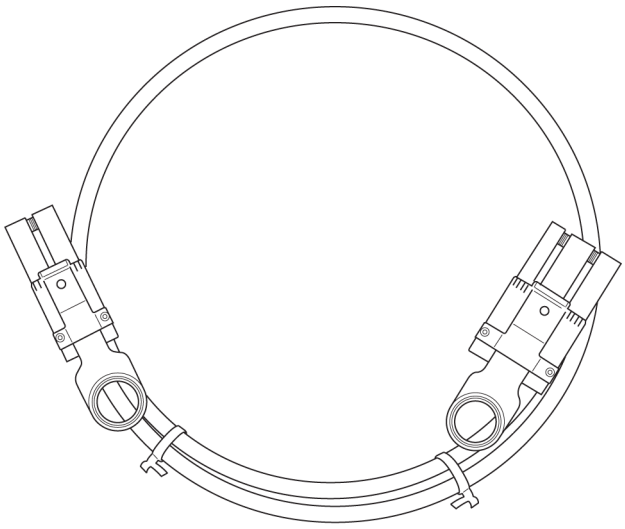


Figure 3.39: iPass Straight Cables

- ❑ 2 Multi-lead Probe pods for x8
  4 Multi-lead Probe pods for x16
  (See Figure 3.36 on page 101).
- ❑ Up to 16 Gen3 Multi-lead Probe Cables, and up to 8 Flexible Leads, per pod.
  (See Figure 3.37 on page 101).
- ❑ 1 Clock Cable (see Figure 3.33 on page 98).

Connections Overview for Gen3 Multi-lead Probe x8 and x16

Use a 2-pod or 4-pod setup depending on the link width of the recording:

- ❑ For x8 recordings, use a two-pod setup (see Figure 3.40 on page 104).
- ❑ For x16 recordings, use the 4-pod setup (see Figure 3.41 on page 105).

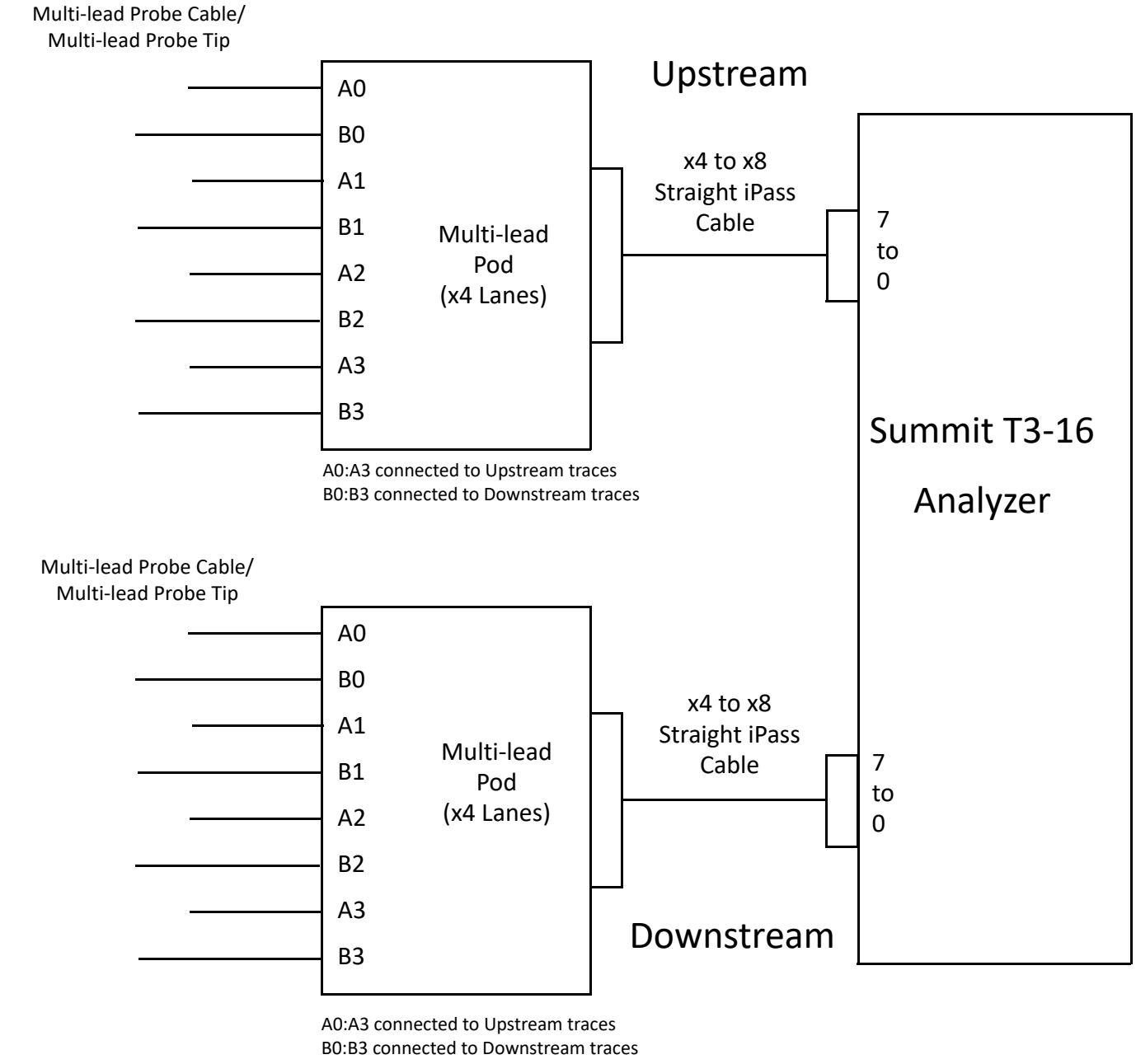
For x8 and x16, use the straight iPass cables to connect the probe data connectors on the Analyzer to the pod(s).

On the other side of the pod, connect the Gen3 Multi-lead Probe and Probe Tip cables.

Connection Procedure

To connect Summit T3-16 to the System Under Test (host platform or root complex under test):

1. Connect the pods to the Analyzer using the straight iPass cables.
2. Connect the Gen3 Multi-lead Probe and Probe Tip cables.
3. Connect the lead tips to the system under test by soldering to the trace.



Drawing not to scale

Figure 3.40: Interconnection Diagram for Summit T3-16 using Two x4 Multi-lead Pods

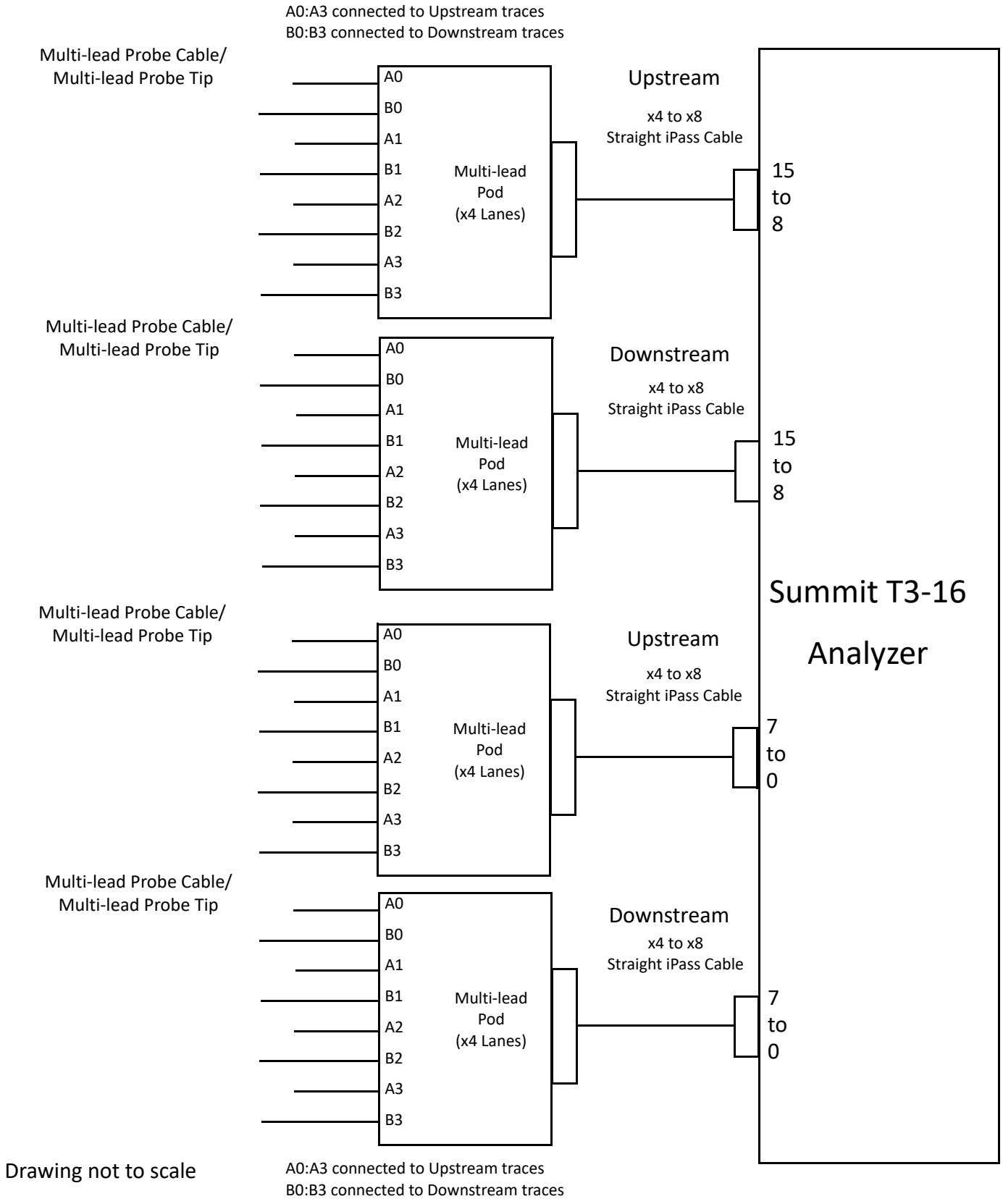


Figure 3.41: Interconnection Diagram for Summit T3-16 using Four x4 Multi-lead Pods

3.4 Interposers and Probes for Use with Summit T3-8 Analyzer

The following sections show a Summit T3-8 Analyzer used with various interposers and probes.

3.4.1 Use of Interposers with Summit T3-8

The following section describes how to connect interposers.

3.4.1.1 Gen3 Interposer

Figure 3.42 shows the Gen3 Interposer Connections

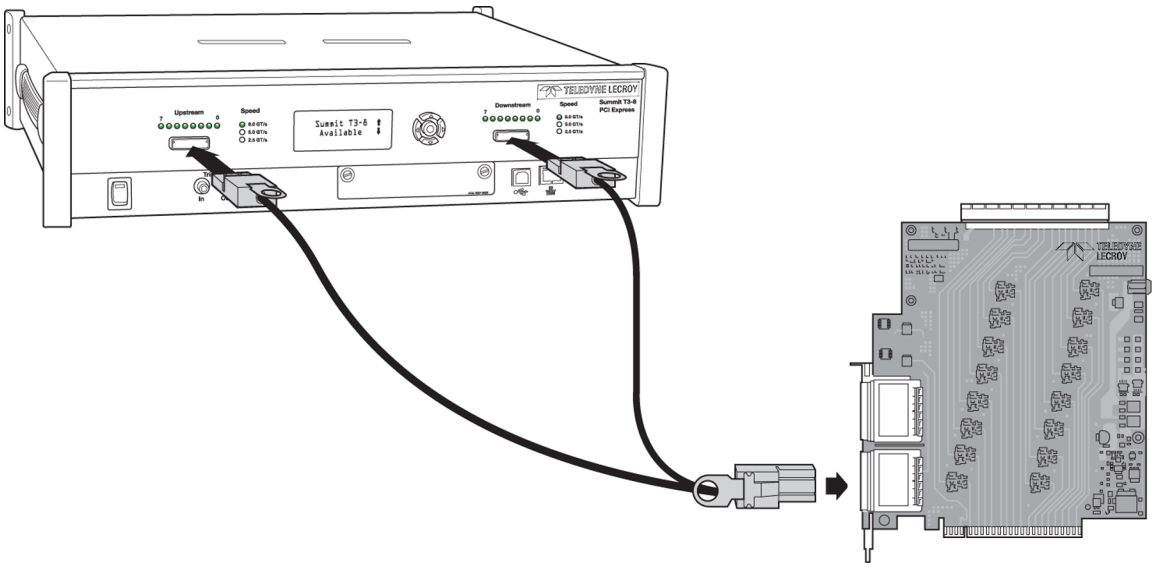


Figure 3.42: Connecting the Summit T3-8 Analyzer to the Device Under Test Using a Gen3 Interposer

Summit T3-8 Components

Summit T3-8 components used in the installation are:

- **iPass Y-Cable**: The cable supports eight lanes from two directions. Side A of the probe cable connects to the Upstream port on the Analyzer (on the left in the photo above), and Side B of the probe cable connects to the Downstream port (on the right). See Figure 3.30 on page 97.

- **x16 Slot Gen3 Interposer**: The Interposer provides the point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer.

Installing the Gen3 Interposer

To install the Interposer, perform the following steps:

1. Insert the gold male connector on the Interposer probe into a x16 PCI Express slot in the motherboard. Interposers are available in x1, x4, x8, and x16 versions.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to the host machine's enclosure.

Connecting the Probe Data Cable

x8 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the Interposer card at [7:0]. Connect Side A of the probe cable to the Upstream [7:0] port on the Analyzer, and connect Side B of the probe cable to the Downstream [7:0] port.

x16 recordings require two cables. Connect the second probe data cable to the Interposer card at [15:8]. Connect Side A of the second probe cable to the Upstream [15:8] port on the Analyzer, and connect Side B of the second probe cable to the Downstream [15:8] port.

3.4.1.2 Gen2 Active Interposer

Figure 3.43 shows the Gen2 Active Interposer Connections

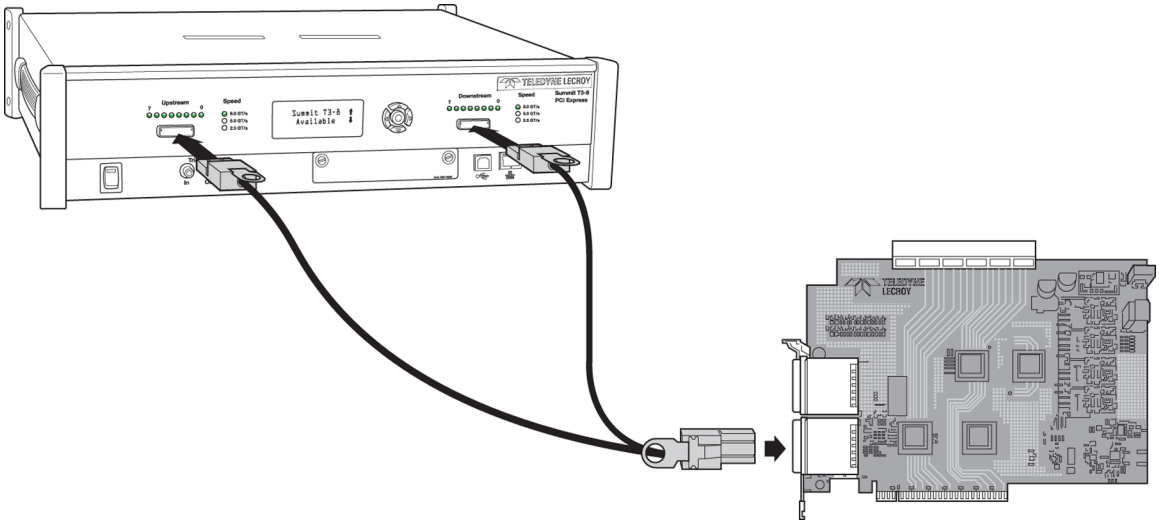


Figure 3.43: Connecting the Summit T3-8 Analyzer to the Device Under Test Using a Gen2 Active Interposer

Summit T3-8 Components

Summit T3-8 components used in the installation are:

- **iPass Y-Cable**: The cable supports eight lanes from two directions. Side A of the probe cable connects to the Upstream port on the Analyzer (on the left in the photo above), and Side B of the probe cable connects to the Downstream port (on the right). Figure 3.30 on page 97.
- **x16 Slot Gen2 Active Interposer**: The Interposer provides the point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed

to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer.

Note: Edge reducers are required for link widths less than x16.

Installing the Gen2 Active Interposer

To install the Interposer, perform the following steps.

1. Insert the gold male connector on the Interposer probe into a x16 PCI Express slot in the motherboard. Use edge adapters for x1, x4, and x8 slots.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to the host machine's enclosure. If you are working with a motherboard that is not in the host machine's enclosure, you may prefer to remove the metal face plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer

Connecting the Probe Data Cable

x8 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the Interposer card at [7:0]. Connect Side A of the probe cable to the Upstream [7:0] port on the Analyzer, and connect Side B of the probe cable to the Downstream [7:0] port.

Power On Analyzer and then DUT

Important: Power on the Analyzer before you power on the DUT.

1. Power on the Summit T3-8 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Analysis on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.4.1.3 Gen2 Passive Interposer

Figure 3.44 shows the Gen2 Passive Interposer Connections

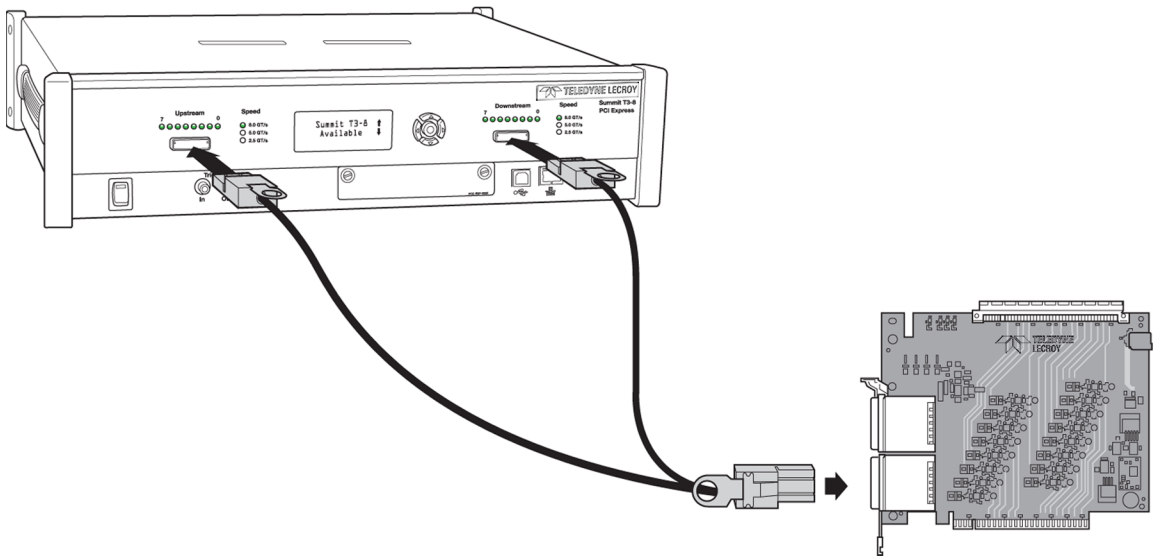


Figure 3.44: Connecting the Summit T3-8 Analyzer to the Device Under Test Using a Gen2 Passive Interposer

Summit T3-8 Components

Summit T3-8 components used in the installation are:

- **iPass Y-Cable**: The cable supports eight lanes from two directions. Side A of the probe cable connects to the Upstream port on the Analyzer (on the left in the photo above), and Side B of the probe cable connects to the Downstream port (on the right). Figure 3.30 on page 97.

- **x16 Slot Gen2 Passive Interposer**: The slot Interposer provides the point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer.

Installing the Gen2 Passive Interposer

To install the Interposer, perform the following steps:

1. Insert the gold male connector on the Interposer probe into a x16 PCI Express slot in the motherboard. Use edge adapters for x1, x4, and x8 slots.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to the host machine's enclosure. If you are working with a motherboard that is not in the host machine's enclosure, you may prefer to remove the metal face

plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer.

Connecting the Probe Data Cable

x8 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the Interposer card at [7:0]. Connect Side A of the probe cable to the Upstream [7:0] port on the Analyzer, and connect Side B of the probe cable to the Downstream [7:0] port.

Power On Analyzer and then DUT

1. Power on the Summit T3-8 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Analysis on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.4.2 Using Probes with the Summit T3-8 Analyzer

The following sections show a Summit T3-8 Analyzer used with various probes.

3.4.2.1 Gen3 MidBus Probe

Components

- ❑ Single iPass Y-cable (see Figure 3.30 on page 97)
- ❑ Gen3 MidBus Probe Pod (see Figure 3.31 on page 97)
- ❑ Full-size Gen3 Mid-bus Probe Cable and Header Assembly (see Figure 3.45)
- ❑ Clock Cable (Figure 3.33 on page 98

Connections Overview for Gen3 MidBus Probe

Use a 1-pod setup:

Use the iPass Y-cables to connect the probe data connectors on the Analyzer to the MidBus pod(s).

On the other side of the pod, connect the MidBus probe assembly.

Connect the header on the MidBus probe assembly to the MidBus footprint on the System Under Test (host platform or root complex under test). The following picture shows two midbus footprints, with one connected to the MidBus probe assembly.

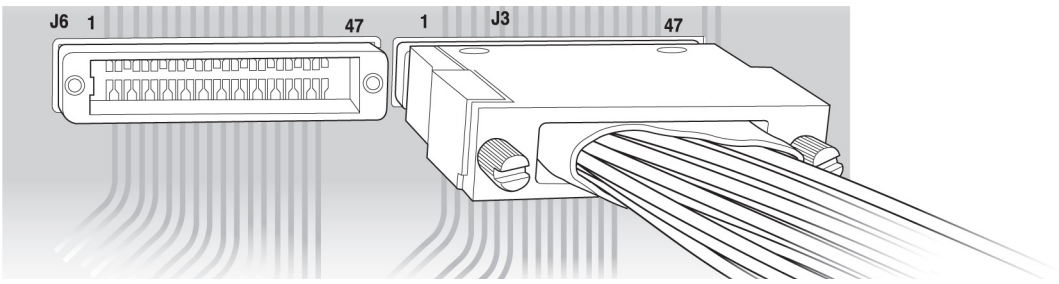


Figure 3.45: Connect Gen3 MidBus Full Size Probes to MidBus Full Size Footprints

Connection Procedure

To connect the Summit T3-8 to the System Under Test (host platform or root complex under test:

1. Connect the MidBus pods to the Analyzer using the iPass Y-cable.
2. Connect the MidBus probe assemblies to the MidBus pod.
3. Connect the MidBus probe assemblies to the MidBus footprint on the system under test.
4. Connect external reference clock signal to Mid-Bus External Clock In on Mid-Bus probe pod, using external reference clock cable.

3.4.2.2 Gen3 Multi-lead Probe for x1 and x4

Components

- ❑ 1 iPass Y-cable for x1 and x4 (see Figure 3.30 on page 97).
- ❑ Gen3 Multi-lead Probe Pod for x1 and x4 (see Figure 3.36 on page 101).
- ❑ 1 Clock Cable (see Figure 3.33 on page 98).
- ❑ Up to 8 Gen3 Multi-lead Probe Cables and up to 8 Flex Probe Tips (see Figure 3.37 on page 101).

Connections for Gen3 Multi-lead Probe Overview

Use a 1-pod setup (see Figure 3.46 on page 112).

For x1 or x4, use the iPass Y-cable to connect the probe data connectors on the Analyzer to the pod(s).

On the other side of the pod, connect the Gen3 Multi-lead Probe Cable and Probe Tips.

Connection Procedure

To connect Summit T3-8 to the System Under Test (host platform or root complex under test):

1. Connect the pods to the Analyzer using the iPass Y-cable cable.
2. Connect the Gen3 Multi-lead Probe Cable and Probe Tip cables to the pod.
3. Connect the lead tips to the system under test by soldering to the trace.

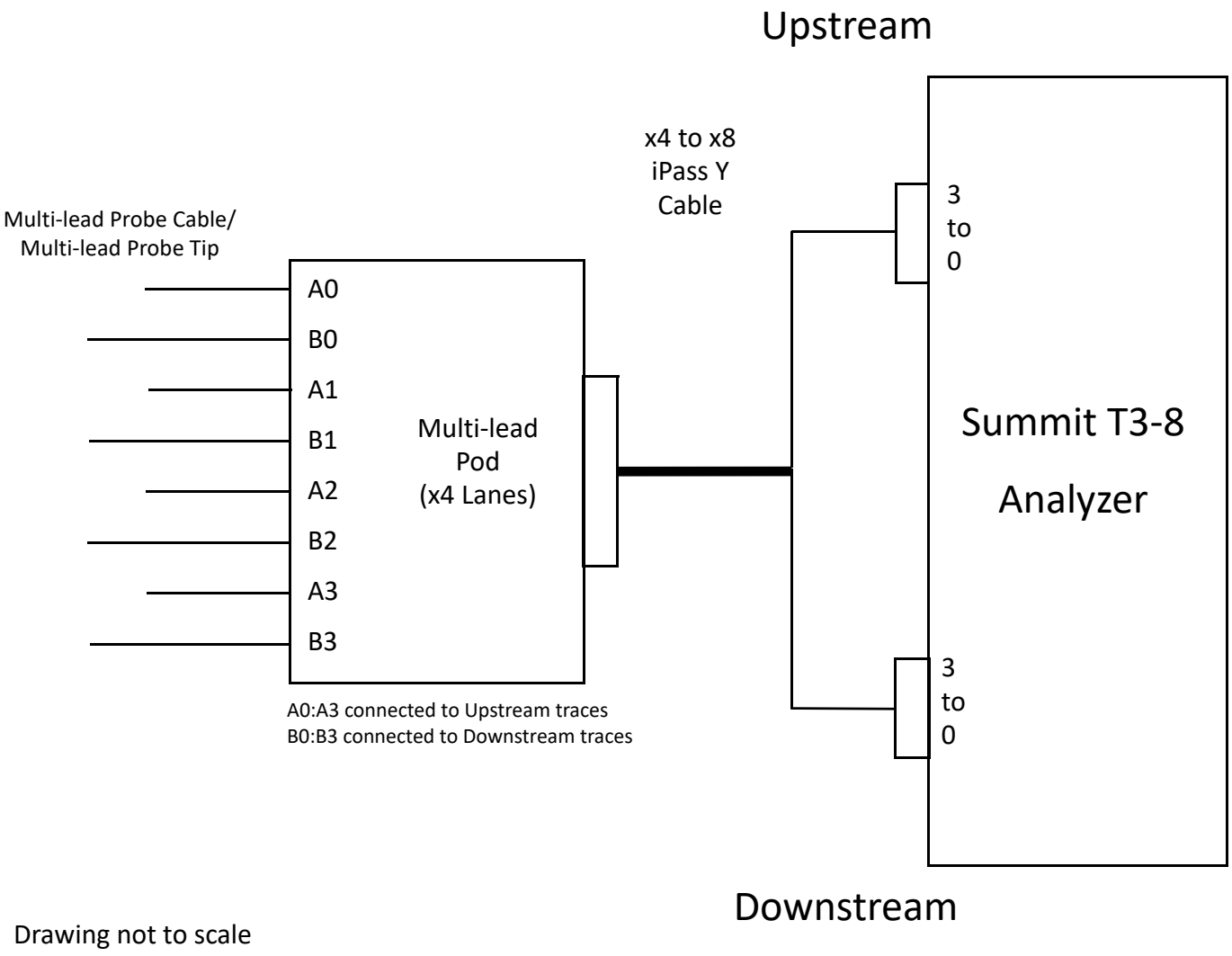


Figure 3.46: Interconnection Diagram for Summit T3-8 using One x4 Multi-lead Pod

3.4.2.3 Gen3 Multi-lead Probe for x8

Components

- ❑ 2 iPass Straight cables for x8 (see Figure 3.39 on page 103)
- ❑ One Clock Cable (see Figure 3.33 on page 98)
- ❑ 2 Gen3 Multi-lead Probe pods for x8 (See Figure 3.36 on page 101).
- ❑ Up to 8 Gen3 Multi-lead Probe Cables and up to 8 Flexible Leads, per pod. (See Figure 3.37 on page 101).
- ❑ 1 Daisy Chain Clock cable per direction for SRIS setup. If no SRIS is used but external clock is needed, then the system will need 1 clock cable and 1 daisy chain clock cable.

Connections Overview for Gen3 Multi-lead Probe

Use a 2-pod setup (see Figure 3.47 on page 114).

For x8, use the straight iPass cables to connect the probe data connectors on the Analyzer to the pods.

On the other side of the pods, connect the Gen3 Multi-lead Probe and Probe Tip cables.

Connection Procedure

To connect Summit T3-8 to the System Under Test (host platform or root complex under test):

1. Connect the pods to the Analyzer using the straight iPass cables.
2. Connect the Gen3 Multi-lead Probe and Probe Tip cables.
3. Connect the lead tips to the system under test by soldering to the trace.

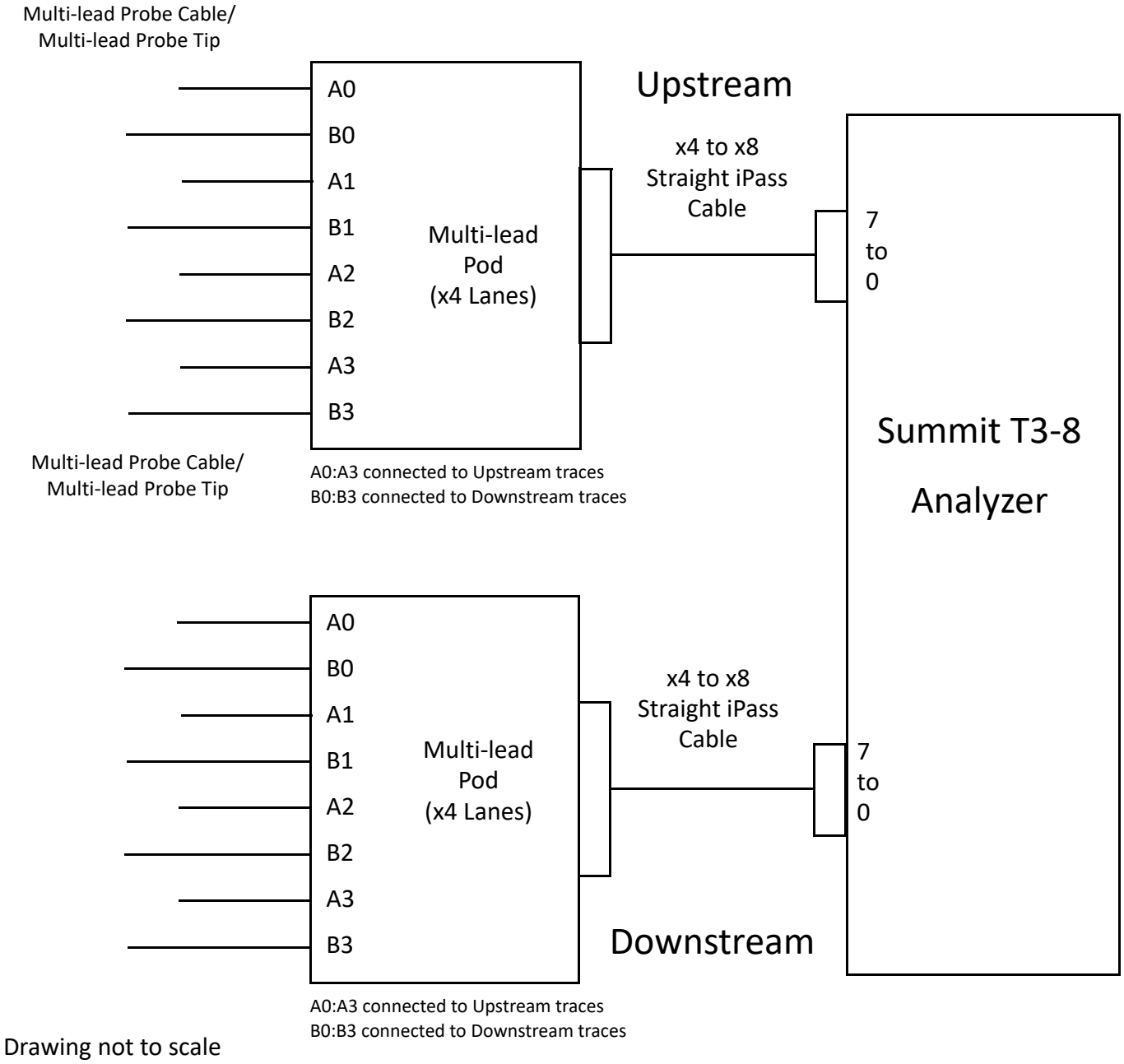


Figure 3.47: Interconnection Diagram for Summit T3-8 using Two x4 Multi-lead Pods

3.5 Interposers and Probes for Use with Summit T34 Analyzer

The following sections show a Summit T34 Analyzer used with various interposers and probes.

3.5.1 Using Interposers with the Summit T34 Analyzer

The following section describes how to connect interposers.

3.5.1.1 Gen3 Interposer

Figure 3.48 shows the Gen3 Interposer connections.

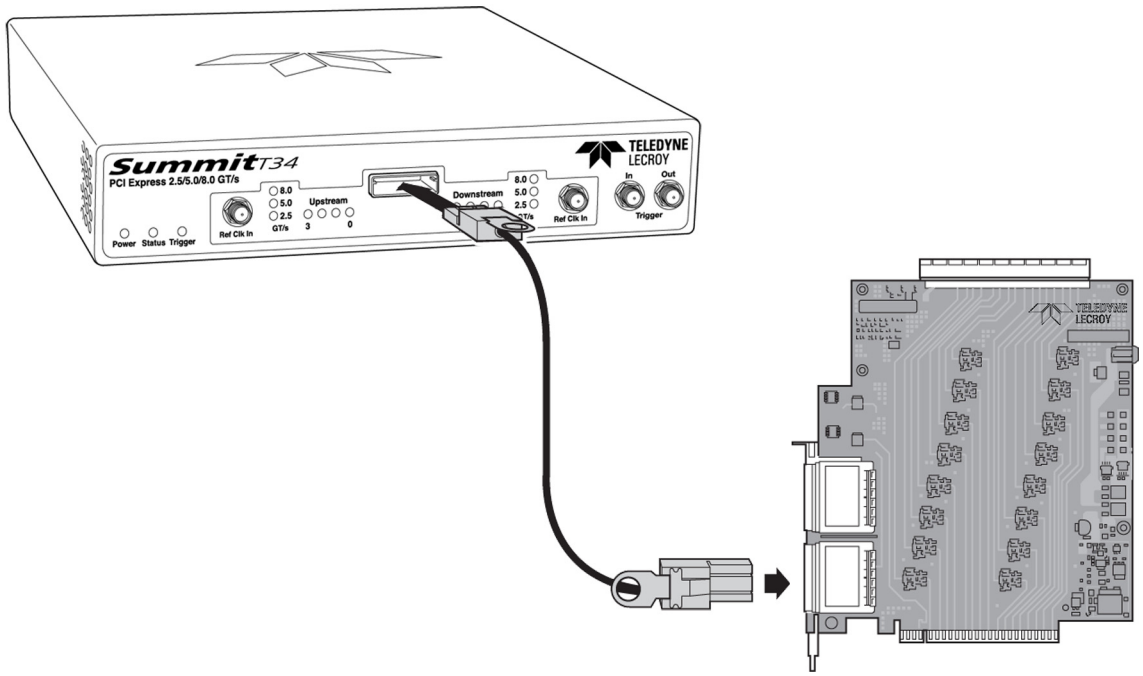


Figure 3.48: Connecting the Summit T34 Analyzer to the Device Under Test Using a Gen3 Interposer.

Summit T34 Components

Summit T34 components used in the installation are:

- **iPass x4 to x8 Straight cable**: The cable supports four lanes from two directions but allows connection to x8 iPass connectors. The smaller x4 end plugs into the Summit T34 and the larger end plugs into the interposer. See Figure 3.39 on page 103.
- **x16 Gen3 Interposer**: The slot Interposer provides a point of attachment for an Analyzer to a Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer.

Installing a Gen3 Interposer

To install an Interposer, perform the following steps:

1. Insert the gold male connector on the Interposer probe into a x16 PCI Express slot in the motherboard. Interposers are available in x1, x8, and x16 versions.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to the host machine's enclosure.

Connecting a Probe Data Cable

x4 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the [7:0] connector of the interposer.

3.5.1.2 Gen2 Active Interposer

Figure 3.49 shows Gen2 Active Interposer connections.

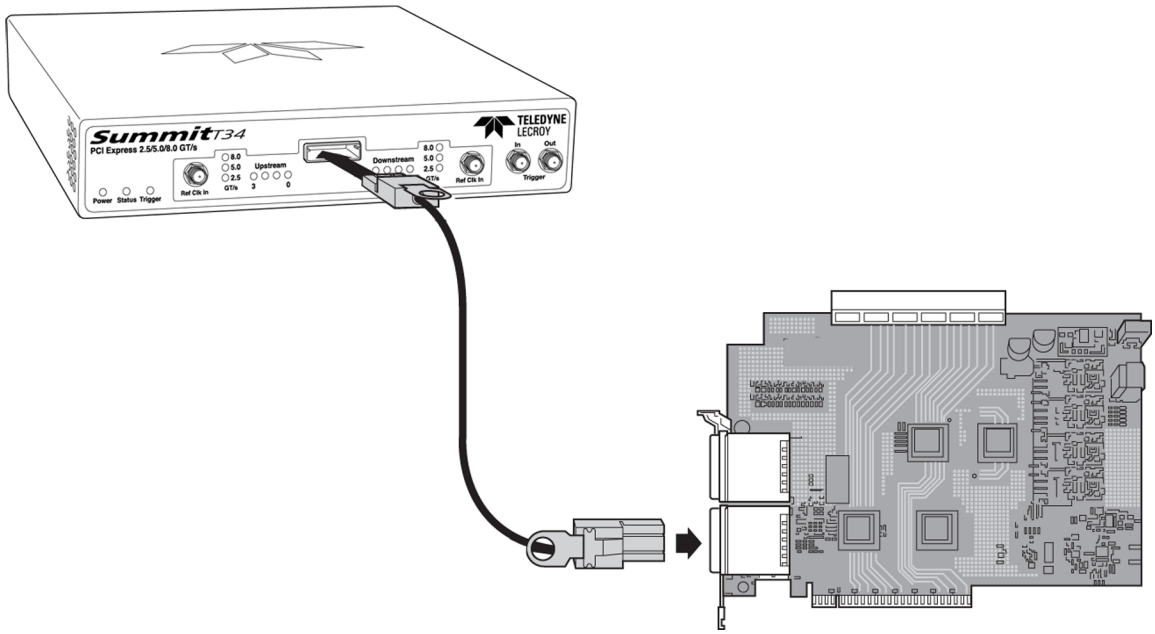


Figure 3.49: Connecting a Summit T34 Analyzer to a Device Under Test Using a Gen2 Active Interposer.

Summit T34 Components

Summit T34 components used in the installation are:

- **iPass x4 to x8 Straight cable**: The cable supports four lanes from two directions but allows connection to x8 iPass connectors. The smaller x4 end plugs into the Summit T34 and the larger end plugs into the interposer. See Figure 3.39 on page 103.
- **x16 Gen2 Active Interposer**: The slot Interposer provides a point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer (only one is used).

Note: Edge reducers are required for link widths less than x16.

Installing a Gen2 Active Interposer

To install an Interposer, perform the following steps.

1. Insert the gold male connector on the Interposer probe into a x16 PCI Express slot in the motherboard. Use edge adapters for x1, and x8 slots.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to the host machine's enclosure. If you are working with a motherboard that is not in the host machine's enclosure, you may prefer to remove the metal face plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer

Connecting the Probe Data Cable

x4 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the [7:0] connector of the interposer.

Power On Analyzer and then DUT

1. Power on the Summit T34 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Analysis on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.5.1.3 Gen2 Passive Interposer

Figure 3.55 shows Gen2 Passive Interposer connections.

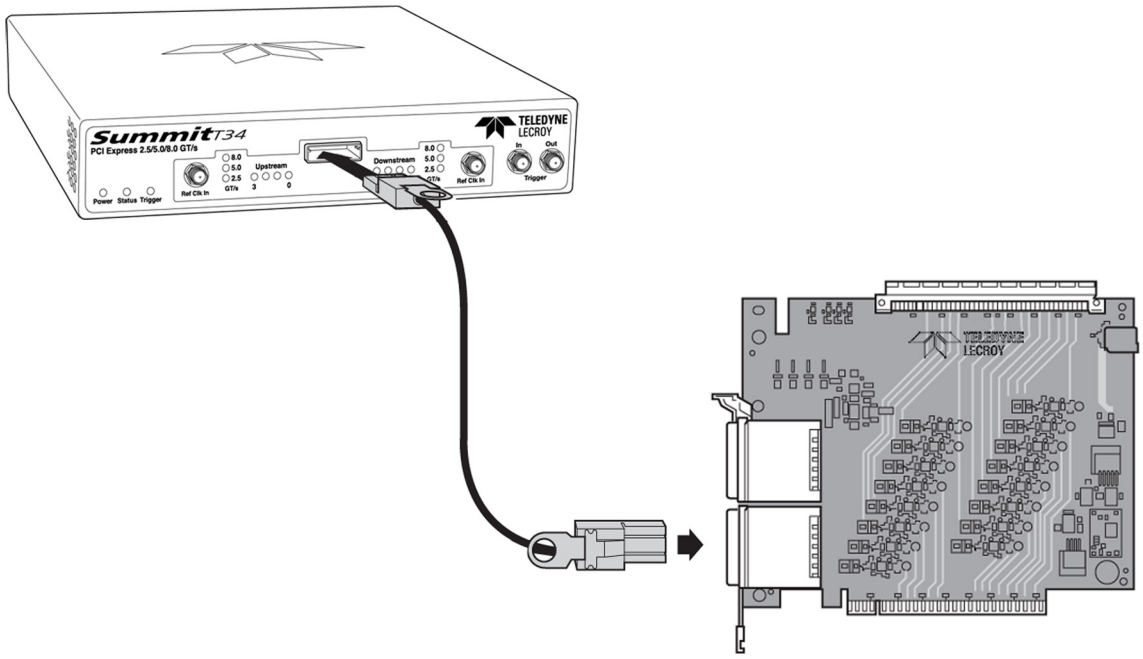


Figure 3.50: Connecting a Summit T34 Analyzer to a Device Under Test Using a Gen2 Passive Interposer.

Summit T34 Components

Summit T34 components used in the installation are:

- **iPass x4 to x8 Straight cable**: The cable supports four lanes from two directions but allows connection to x8 iPass connectors. The smaller x4 end plugs into the Summit T34 and the larger end plugs into the interposer. See Figure 3.39 on page 103.
- **x16 Gen2 Active Interposer**: The slot Interposer provides a point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer (only one is used).

Note: Edge reducers are required for link widths less than x16.

Installing a Gen2 Passive Interposer

To install an Interposer, perform the following steps.

1. Insert the gold male connector on the Interposer probe into a x16 PCI Express slot in the motherboard. Use edge adapters for x1, and x8 slots.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to the host machine's enclosure. If you are working with a motherboard that is not in the host machine's enclosure, you may prefer to remove the metal face plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer

Connecting the Probe Data Cable

x4 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the [7:0] connector of the interposer.

Power On Analyzer and then DUT

1. Power on the Summit T34 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Analysis on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.5.2 Using Probes with the Summit T34

The following sections show a Summit T34 Analyzer used with various probes.

3.5.2.1 Gen3 MidBus Probe

Note: Mid-bus probes require attachment-pad and reference-clock connections. For information about how to connect the attachment pad, reference clock, and cables in your system, see the *MidBus Probe Manual*.

Components

- ❑ iPass x4 to x8 Straight Cable (see Figure 3.39 on page 103).
- ❑ Gen 3 MidBus Probe Pod (Figure 3.31 on page 97).
- ❑ Full-size Gen3 Mid-bus Probe Cable and Header Assembly (see Figure 3.32 on page 98)
- ❑ Clock Cable (see Figure 3.33 on page 98).

Connections Overview for Gen3 MidBus Probe

- ❑ Use a 1-pod setup.

1. Use an iPass straight cable to connect probe data connectors on the Analyzer to the MidBus pod(s).
2. On the other side of the pod, connect the MidBus probe assembly.
3. Connect the header on the MidBus probe assembly to the MidBus footprint on the system under test (host platform or root complex under test). Figure 3.51 shows two MidBus footprints, with one connected to the MidBus probe assembly.

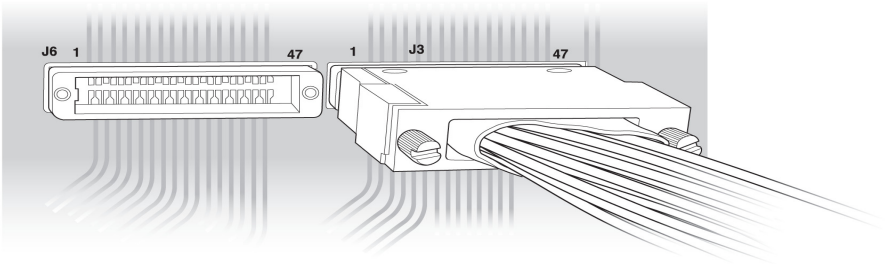


Figure 3.51: Connect MidBus Probe to MidBus Footprint.

Connection Procedure

To connect a Summit T34 to a system under test (host platform or root complex under test):

1. Connect the MidBus pods to the Analyzer using a iPass x4 to x8 Straight cable.
2. Connect the MidBus probe assemblies to the MidBus pods.
3. Connect the MidBus probe assemblies to the MidBus footprints on the system under test.
4. Connect external reference clock signal to Mid-Bus External Clock In on Mid-Bus probe pod, using external reference clock cable.

3.5.3 Gen3 Multi-lead Probe for x1 and x4

Components

- ❑ 1 iPass x4 to x8 Straight cable for x1 and x4. (See Figure 3.39 on page 103.)
- ❑ 1 Multi-lead Probe Pod for x1 and x4. (See Figure 3.36 on page 101.)
- ❑ Up to 8 Gen3 Multi-lead Probe Cable and 8 Probe Tips, per pod. (See Figure 3.37 on page 101.)
- ❑ 1 Clock Cable. (See Figure 3.33 on page 98.)

Connection Overview for Gen3 Multi-lead Probe

- ❑ Use a 1-pod setup. See Figure 3.52 on page 122.

1. For x1 or x4, use the iPass x4 to x8 Straight cable to connect the probe data connectors on the Analyzer to the pod(s).
2. On the other side of the pod, connect the Gen3 Multi-lead Probe Cable and Probe Tips.

Connection Procedure

To connect Summit T34 to a system under test (host platform or root complex under test):

1. Connect the pods to the Analyzer using a iPass x4 to x8 Straight cable.
2. Connect the Gen3 Multi-lead Probe Cable and Probe Tip cables to the pods.
3. Connect the lead tips to the system under test by soldering to the trace.

3.5.4 Gen3 Multi-lead Probe for x8

Components

- ❑ 2 iPass Straight cables for x8. (See Figure 3.39 on page 103.)
- ❑ 2 Multi-lead Probe pods for x8. (See Figure 3.36 on page 101.)
- ❑ Up to 8 Gen3 Multi-lead Probe Cables and up to 8 Flexible Leads, per pod. (See Figure 3.37 on page 101.)
- ❑ 1 Clock Cable. (See Figure 3.33 on page 98.)
- ❑ 2 Summit T34 Analyzers. (See Figure 3.53 on page 122.)
- ❑ 1 Daisy Chain Clock cable per direction for SRIS setup. If no SRIS is used but external clock is needed, then the system will need 1 clock cable and 1 daisy chain clock cable.

Connections Overview for Gen3 Multi-lead Probe

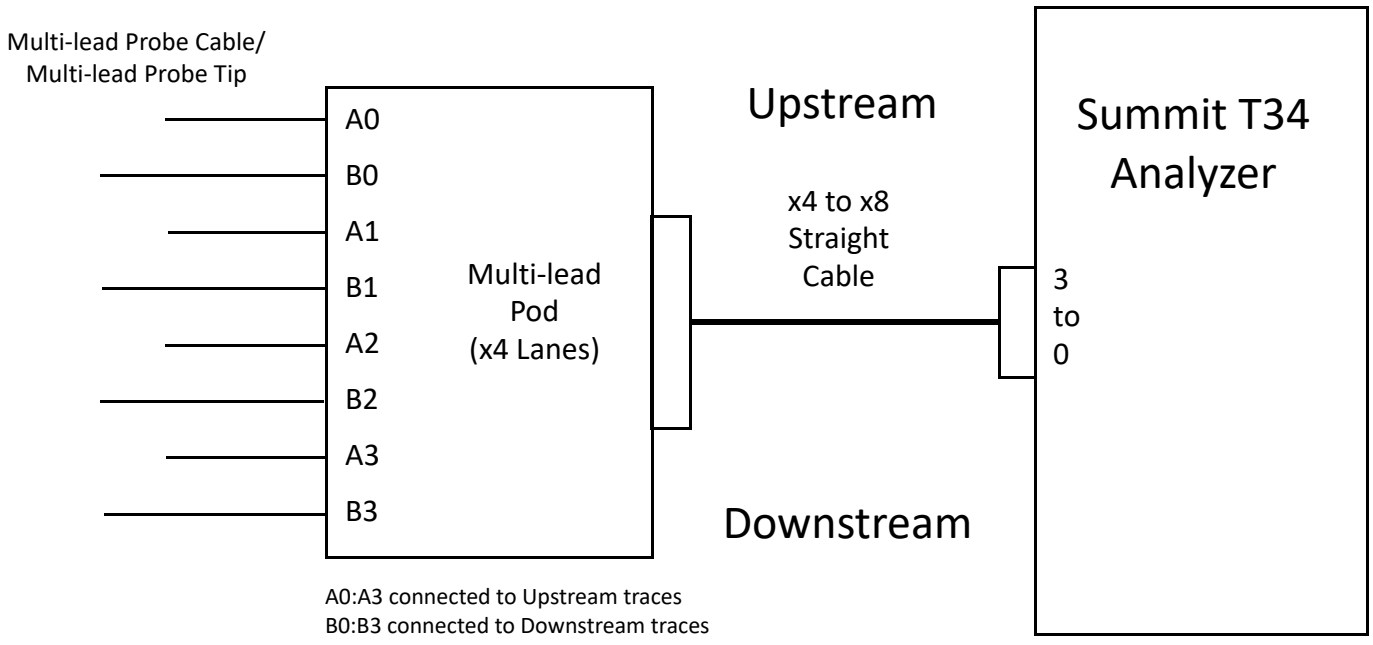
- ❑ Use a 2-pod setup.

1. For x8, use the straight iPass cables to connect the probe data connectors on the Analyzers to the pods.
2. On the other side of the pod, connect the Gen3 Multi-lead Probe Cable and Probe Tip cables.

Connection Procedure

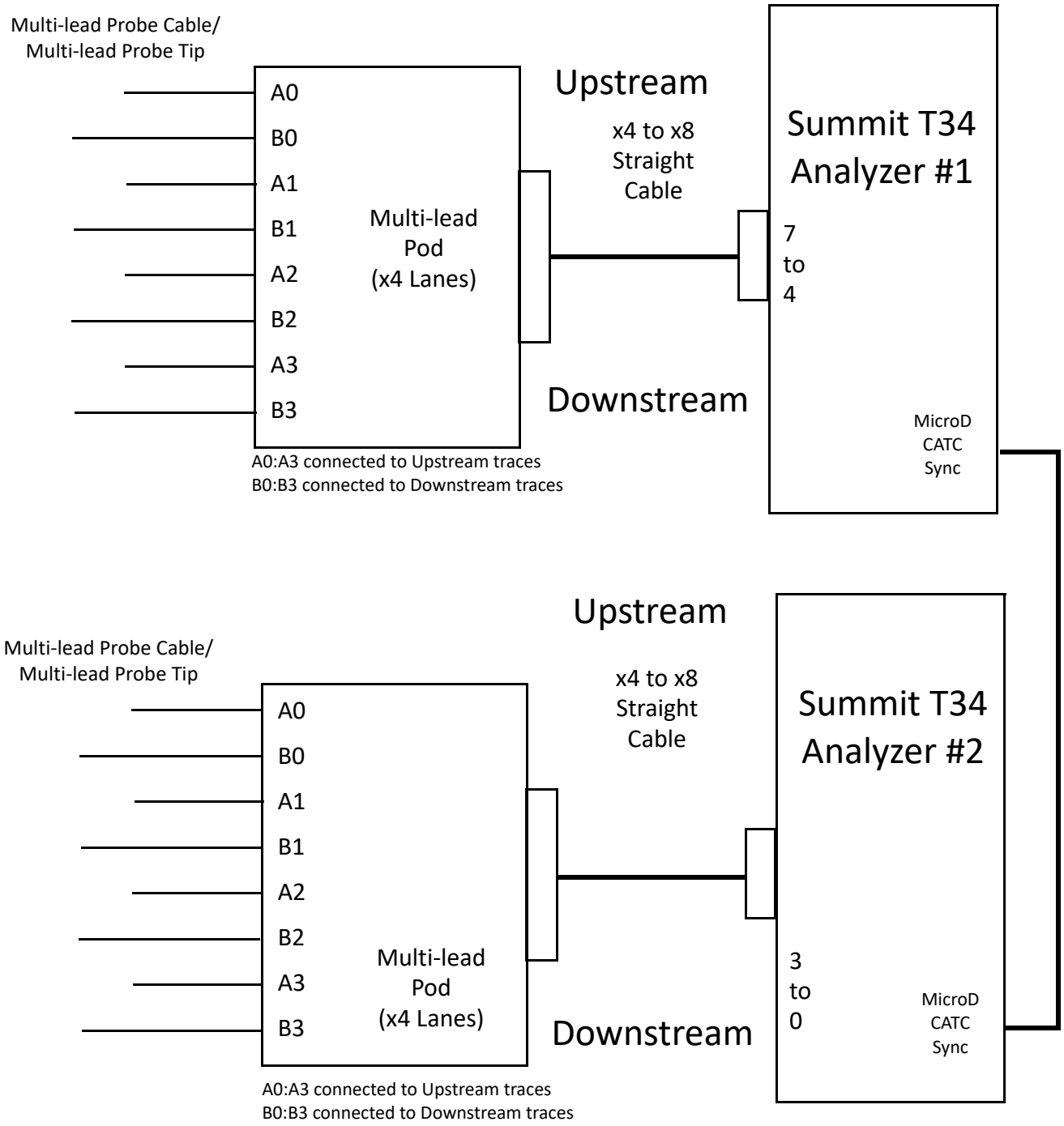
To connect Summit T34s to a system under test (host platform or root complex under test):

1. Connect the pods to the Analyzers using the straight iPass cables.
2. Connect the Gen3 Multi-lead Probe Cable and Probe Tip cables to the pods.
3. Connect the lead tips to the system under test by soldering to the trace.



Drawing not to scale

Figure 3.52: Interconnect Drawing: Gen2/Gen3 Multi-lead x4 Pod to Summit T34



Drawing not to scale

Figure 3.53: Using T34s With Multi-lead Probe Pods and Time Synchronized Traces

3.6 Interposers and Probes for Use with Summit T28 Analyzer

The following sections show a Summit T28 Analyzer used with various interposers and probes.

3.6.1 Using Interposers with the Summit T28

The following section describes how to connect interposers.

3.6.1.1 Gen2 Active Interposer

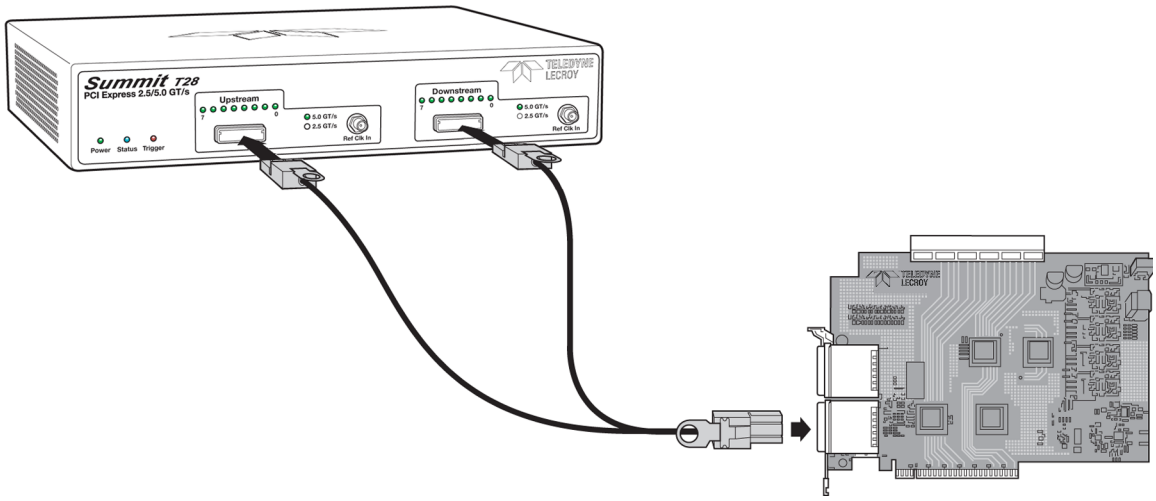


Figure 3.54: Connecting the Summit T28 Analyzer to the Device Under Test Using a Gen2 Active Interposer

Summit T28 Components

Summit T28 components used in the installation are:

- **iPass Y-Cable**: The cable supports eight lanes from two directions. Side A of the probe cable connects to the Upstream port on the Analyzer (on the left in the photo above), and Side B of the probe cable connects to the Downstream port (on the right).

- **x16 Slot Gen2 Active Interposer**: The slot Interposer provides the point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x8 PCI Express slot on a motherboard, a PCIe female connector that accepts a x8 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer.

Note: Edge reducers are required for link widths less than x8.

Installing the Gen2 Active Interposer

To install the Interposer, perform the following steps.

1. Insert the gold male connector on the Interposer probe into a x8 PCI Express slot in the motherboard. Use edge adapters for x1 and x4 slots.

2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to a PC case. If you are working with a motherboard that is not in a PC case, you may prefer to remove the metal face plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer

Connecting the Probe Data Cable

x8 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the Interposer card at [7:0]. Connect Side A of the probe cable to the Upstream [7:0] port on the Analyzer, and connect Side B of the probe cable to the Downstream [7:0] port.

Power On Analyzer and then DUT

1. Power on the Summit T28 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Analysis on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.6.1.2 Gen2 Passive Interposer

Figure 3.55 shows Gen2 Passive Interposer connections.

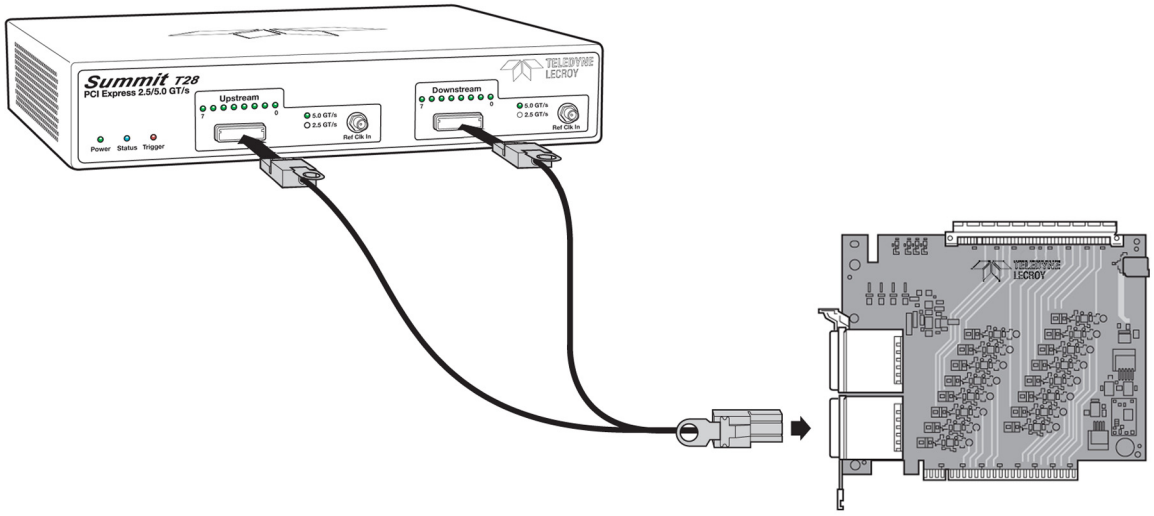


Figure 3.55: Connecting a Summit T28 Analyzer to a Device Under Test Using a Gen2 Passive Interposer.

Summit T28 Components

Summit T28 components used in the installation are:

- **iPass x4 to x8 Straight cable**: The cable supports four lanes from two directions but allows connection to x8 iPass connectors. The smaller x4 end plugs into the Summit T28 and the larger end plugs into the interposer.
- **x16 Gen2 Active Interposer**: The slot Interposer provides a point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into

a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer (only one is used).

Note: Edge reducers are required for link widths less than x16.

Installing a Gen2 Passive Interposer

To install an Interposer, perform the following steps.

1. Insert the gold male connector on the Interposer probe into a x16 PCI Express slot in the motherboard. Use edge adapters for x1, and x8 slots.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to the host machine's enclosure. If you are working with a motherboard that is not in the host machine's enclosure, you may prefer to remove the metal face plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer

Connecting the Probe Data Cable

x4 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the [7:0] connector of the interposer.

Power On Analyzer and then DUT

1. Power on the Summit T28 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Analysis on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.6.2 Using Probes with the Summit T28

The following sections show a Summit T28 Analyzer used with various probes.

3.6.2.1 Gen2 MidBus Probe

Note: Mid-bus probes require attachment-pad and reference-clock connections. For information about how to connect the attachment pad, reference clock, and cables in your system, see the *MidBus Probe Manual*.

Components

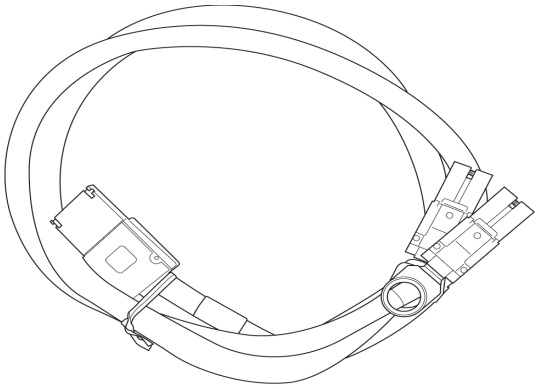


Figure 3.56: iPass Y-cable

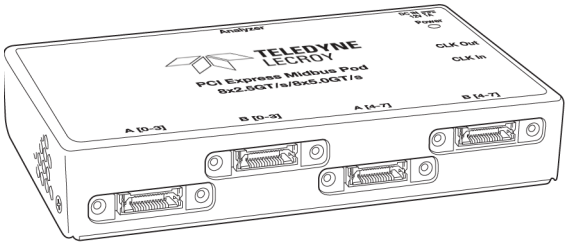


Figure 3.57: Gen2 MidBus Probe pod

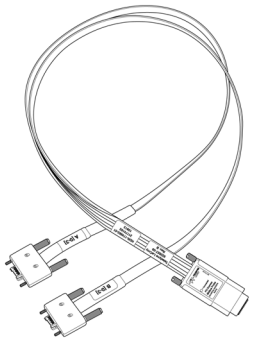


Figure 3.58: Half-size Gen2 Mid-bus Probe Cable and Header Assembly

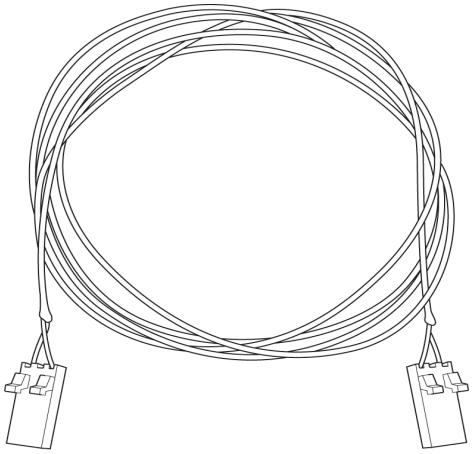


Figure 3.59: Clock Cable

Connections Overview for Gen2 MidBus Probe

Use a 1-pod setup.

Use the iPass Y-cables to connect the probe data connectors on the Analyzer to the MidBus pod(s).

On the other side of the pod, connect the MidBus probe assembly.

Connect the header on the MidBus probe assembly to the MidBus footprint on the System Under Test (host platform/root complex). The following picture shows two midbus footprints, with one connected to the MidBus probe assembly.

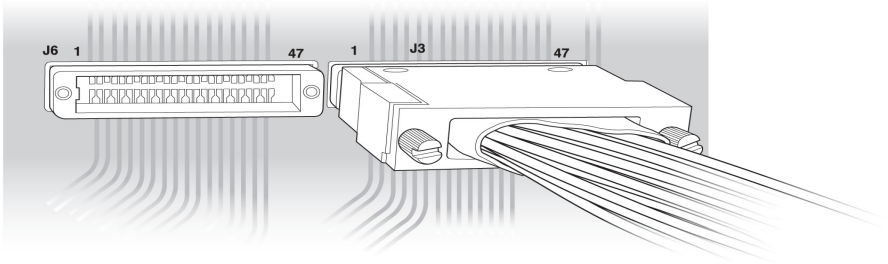


Figure 3.60: Connect MidBus Probe to MidBus Footprint

Connection Procedure

To connect the Summit T28 to the System Under Test (host platform/root complex):

1. Connect the MidBus pods to the Analyzer using the iPass Y-cables.
2. Connect the MidBus probe assemblies to the MidBus pods.
3. Connect the MidBus probe assemblies to the MidBus footprints on the system under test.
4. Connect external reference clock signal to Mid-Bus External Clock In on Mid-Bus probe pod, using external reference clock cable.

3.6.2.2 Gen2 Multi-lead Probe for x1 and x4

Components

- ❑ 1 iPass Y-cable for x1 and x4 (see Figure 3.56 on page 126).
- ❑ 1 Multi-lead Probe Pod for x1 and x4 see Figure 3.61 below).

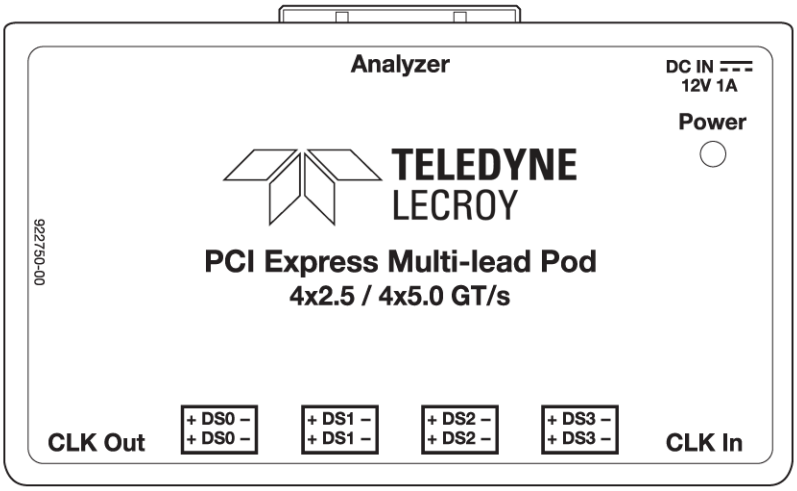


Figure 3.61: Gen2 Multi-Lead Probe Pod

- ❑ Up to 16 MidBus Probe SSMP Cables, and up to 8 Flexible Leads, per pod (see Figure 3.62 below)



Figure 3.62: Gen2 Midbus Probe SSMP Cables

- ❑ **1 Clock Cable** (see Figure 3.33 on page 98).

Connections Overview for Gen2 Multi-lead Probe

Use a 1-pod setup.

For x1 or x4, use the iPass Y-cable to connect the probe data connectors on the Analyzer to the pod(s).

On the other side of the pod, connect the flexible lead tips.

Connection Procedure

To connect Summit T28 to the System Under Test (host platform/root complex):

1. Connect the pods to the Analyzer using the iPass Y-cable cables.

2. Connect the flexible lead tips to the pods using the SSMP cables.
3. Connect the lead tips to the system under test by soldering to the trace.

3.6.2.3 Gen2 Multi-lead Probe for x8

Components

- ❑ 2 iPass Straight cables for x8 (see Figure 3.63 below)

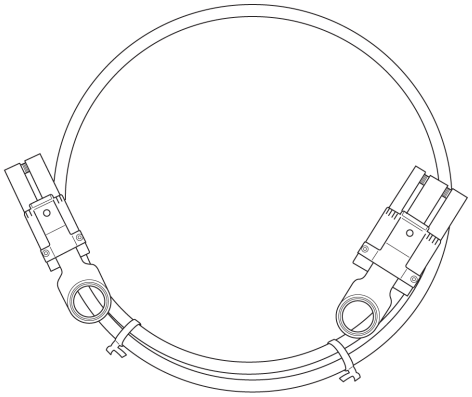


Figure 3.63: iPass x4 to x8 Straight Cable

- ❑ 2 Multi-lead Probe pods for x8 (See Figure 3.61 on page 128).
- ❑ Up to 16 MidBus Probe SSMP Cables, and up to 8 Flexible Leads, per pod. (See Figure 3.62 on page 128).
- ❑ 1 Clock Cable (see Figure 3.59 on page 127).

Connections Overview for Gen2 Multi-lead Probe

Use a 1-pod setup.

For x8, use the straight iPass cable to connect the probe data connectors on the Analyzer to the pod(s).

On the other side of the pod, connect the flexible lead tips.

Connection Procedure

To connect Summit T28 to the system under test (host platform/root complex):

1. Connect the pods to the Analyzer using the straight iPass cables.
2. Connect the flexible lead tips to the pods using the SSMP cables.
3. Connect the lead tips to the system under test by soldering to the trace.

3.7 Interposers and Probes for Use with Summit T24 Analyzer

The following sections show a Summit T24 Analyzer used with various interposers and probes.

3.7.1 Using Interposers with the Summit T24 Analyzer

The following section describes how to connect interposers.

3.7.1.1 Gen2 Active Interposer

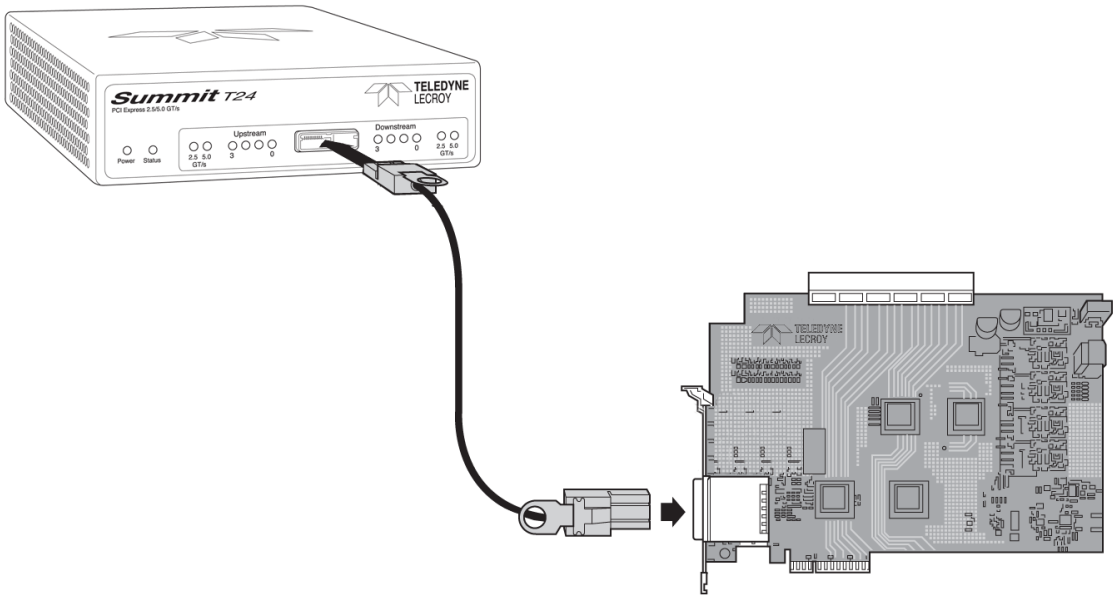


Figure 3.64: Connecting the Summit T24 Analyzer to the Device Under Test Using a Gen2 Active Interposer

Summit T24 Components

Summit T24 components used in the installation are:

- **iPass x4 to x8 Straight cable**: The cable supports four lanes from two directions but allows connection to x8 iPass connectors. The smaller x4 end plugs into the Summit T24 and the larger end plugs into the interposer. See
- **Summit T24 x4 Slot Gen2 Passive Interposer**: The slot Interposer provides the point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x4 up to x16 PCI Express slot on a motherboard, a PCIe female connector that accepts any PCI Express add in card. Although the PCIe female connector will accept up to x16 male connectors, only four lanes will be passed through the x4 interposer.

Note: If using X8 or X16 interposers, link width reducers may be needed to analyze the link.

Installing the Gen2 Active Interposer

To install the Interposer, perform the following steps.

1. Insert the gold male connector on the Interposer probe into a x4, x8 or x16 PCI Express slot in the motherboard. If a X1 link is required, use edge adapter for x1.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to a PC case. If you are working with a motherboard that is not in a PC case, you may prefer to remove the metal face plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer

Connecting the Probe Data Cable

x4 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the Interposer card at [3:0]. Connect Side A of the probe cable to the Upstream [3:0] port on the Analyzer, and connect Side B of the probe cable to the Downstream [3:0] port.

Power On Analyzer and then DUT

1. Power on the Summit T24 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Analysis on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.7.1.2 Gen2 Passive Interposer

Figure 3.55 shows Gen2 Passive Interposer connections.

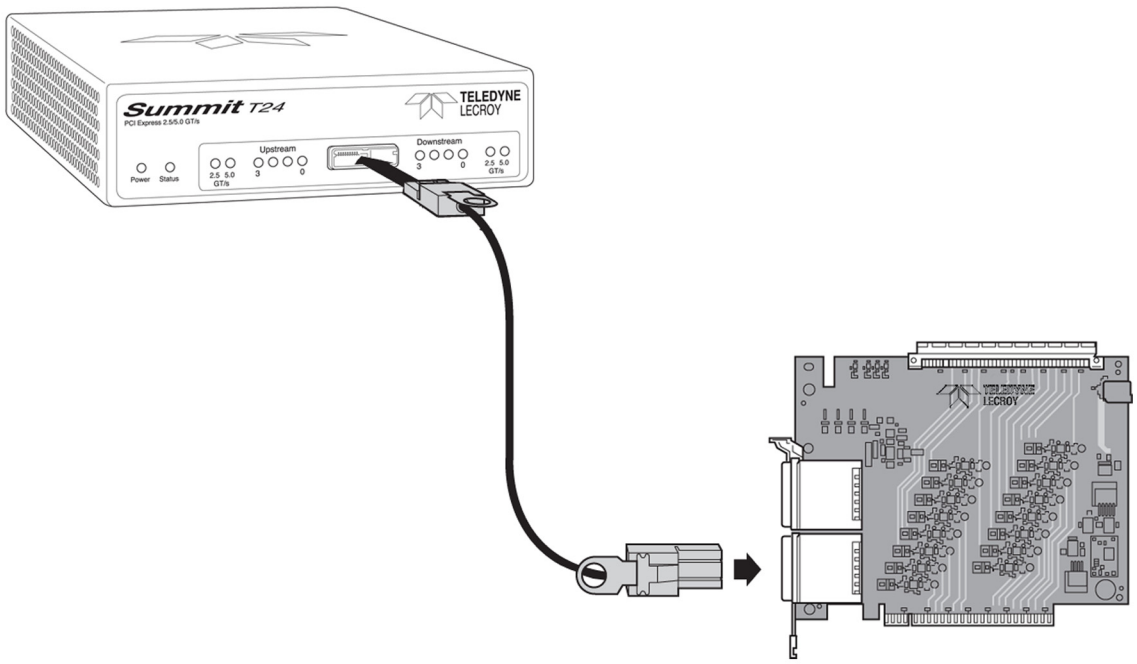


Figure 3.65: Connecting a Summit T24 Analyzer to a Device Under Test Using a Gen2 Passive Interposer.

Summit T24 Components

Summit T24 components used in the installation are:

- **iPass x4 to x8 Straight cable**: The cable supports four lanes from two directions but allows connection to x8 iPass connectors. The smaller x4 end plugs into the Summit T24 and the larger end plugs into the interposer.
- **x16 Gen2 Active Interposer**: The slot Interposer provides a point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x16 PCI Express slot on a motherboard, a PCIe female connector that accepts a x16 PCI Express device, and two Interposer cable connectors that connect the Interposer to the Analyzer (only one is used).

Note: Edge reducers are required for link widths less than x16.

To install the Interposer, perform the following steps.

1. Insert the gold male connector on the Interposer probe into a x4, x8 or x16 PCI Express slot in the motherboard. If a X1 link is required, use edge adapter for x1.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to a PC case. If you are working with a motherboard that is not in a PC

case, you may prefer to remove the metal face plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer

Connecting the Probe Data Cable

x4 recordings require one cable. To connect a single Interposer data cable, connect the probe data cable to the Interposer card at [3:0]. Connect Side A of the probe cable to the Upstream [3:0] port on the Analyzer, and connect Side B of the probe cable to the Downstream [3:0] port.

Power On Analyzer and then DUT

1. Power on the Summit T24 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Analysis on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.7.2 Using Probes with the Summit T24 Analyzer

The following sections show a Summit T24 Analyzer used with various probes.

3.7.2.1 Gen2 MidBus Probe

Note: Mid-bus probes require attachment-pad and reference-clock connections. For information about how to connect the attachment pad, reference clock, and cables in your system, see the *MidBus Probe Manual*.

Components

- ❑ iPass x4 to x8 Straight Cable (see Figure 3.63 on page 129)
- ❑ Gen2 Mid-bus Probe Pod for Summit T24 (see Figure 3.57 on page 126)
- ❑ Half-size Gen2 Mid-bus Probe Cable and Header Assembly (see Figure 3.58 on page 126)
- ❑ Clock Cable (see Figure 3.59 on page 127)
- ❑ iPass x4 to x8 Straight Cable(s) (see Figure 3.63 on page 129)

Connections Overview for Gen2 MidBus Probe

Use a 1-pod setup.

Use the iPass x4 to x8 Straight cable to connect the probe data connectors on the Analyzer to the MidBus pod(s).

On the other side of the pod, connect the MidBus probe assembly.

Connect the header on the MidBus probe assembly to the MidBus footprint on the System Under Test (host platform/root complex). The following picture shows two midbus footprints, with one connected to the MidBus probe assembly.

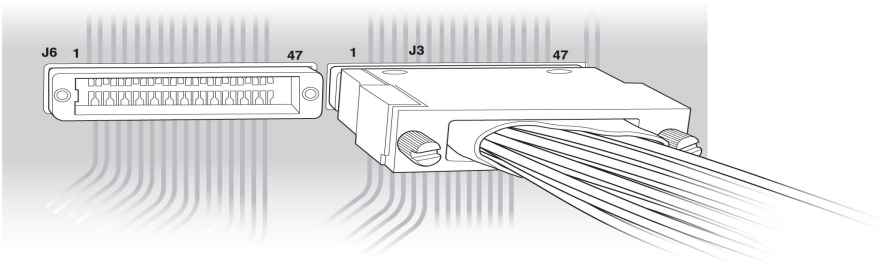


Figure 3.66: Connect MidBus Probe to MidBus Footprint

Connection Procedure

To connect the Summit T24 to the System Under Test (host platform/root complex):

1. Connect the MidBus pods to the Analyzer using the iPass x4 to x8 Straight cable.
2. Connect the MidBus probe assemblies to the MidBus pods.
3. Connect the MidBus probe assemblies to the MidBus footprints on the system under test.
4. Connect external reference clock signal to Mid-Bus External Clock In on Mid-Bus probe pod, using external reference clock cable.

3.7.2.2 Gen2 Multi-lead Probe for x1 and x4

Components

- ❑ iPass x4 to x8 Straight cable for x1 and x4 (see Figure 3.63 on page 129).
- ❑ 1 Multi-lead Probe Pod for x1 and x4 (see Figure 3.61 on page 128)
- ❑ Up to 16 Multi-lead Probe SSMP Cables, and up to 8 Flexible Leads, per pod (see Figure 3.62 on page 128)
- ❑ 1 Clock Cable (see Figure 3.59 on page 127).

Connections Overview for Gen2 Multi-lead Probe

Use a 1-pod setup.

For x1 or x4, use the iPass x4 to x8 Straight cable to connect the probe data connectors on the Analyzer to the pod(s).

On the other side of the pod, connect the flexible lead tips.

Connection Procedure

To connect Summit T24 to the System Under Test (host platform/root complex):

1. Connect the pods to the Analyzer using the iPass x4 to x8 Straight cable.
2. Connect the flexible lead tips to the pods using the SSMP cables.
3. Connect the lead tips to the system under test by soldering to the trace.

3.7.2.3 Gen2 Multi-lead Probe for x4

Components

- ❑ 1 iPass x4 to x8 Straight cable for x4 (see Figure 3.63 on page 129)
- ❑ 2 Multi-lead Probe pods for x4 (see Figure 3.61 on page 128)
- ❑ Up to 16 MidBus Probe SSMP Cables, and up to 8 Flexible Leads, per pod. (See Figure 3.62 on page 128).
- ❑ 1 Clock Cable (see Figure 3.59 on page 127).

Connections Overview for Gen2 Multi-lead Probe

Use a 1-pod setup.

For x4, use the straight iPass cable to connect the probe data connectors on the Analyzer to the pod(s).

On the other side of the pod, connect the flexible lead tips.

Connection Procedure

To connect Summit T24 to the system under test (host platform/root complex):

1. Connect the pods to the Analyzer using the straight iPass cables.
2. Connect the flexible lead tips to the pods using the SSMP cables.
3. Connect the lead tips to the system under test by soldering to the trace.

3.8 Daisy-Chaining with CATC SYNC Expansion Cards

You may daisy-chain up to eight analyzer units by connecting the units through the optional CATC SYNC Expansion Card on the analyzer rear panel (or front panel depending on the analyzer).

You can daisy-chain two Analyzers, if they both have a CATC SYNC port:

After Analyzers are connected, recording will start simultaneously and triggers will occur simultaneously, with synchronized timestamps.

You must select both Analyzers in the Device List dialog.

Important: If you are using other analyzers (NOT PCIe!) in your daisy chain (this would include USB, DDR, SAS, FC and GigE) and do not wish to use the daisy chaining feature of synchronized recordings, you must UNPLUG the cable! If you do not unplug, the electrical signal prevents recording on all Analyzers.

Daisy-chained analyzer units will have their timestamping, recording, and triggering functions synchronized to +/- 100ns.

3.8.1 Example: Daisy-Chain Summit T3-8 with Summit T3-16

In this example, we daisy-chain the following analyzers, which already have the CATC Sync cards installed. For details of installing or extracting CATC Sync cards see "CATC Sync Expansion Slots for Summit T3-16 and Summit T3-8" on page 138.

- ❑ Summit T3-8
- ❑ Summit T3-16

Note: More combinations of analyzers are possible, contact psgsupport@teledynelecroy.com for more details.

Perform the following steps to connect the CATC Sync ports between two or more analyzers:

1. Make sure to stop any recordings in progress.

Note: You may plug/unplug the sync cable while the analyzer unit is powered on.

2. Connect the female end of the sync cable to the SYNC OUT port of one Analyzer.
3. Connect the male end of the sync cable to the SYNC IN port of the other Analyzer (see Figure 3.67 on page 137.)
4. Repeat steps 2-3 to connect additional units (up to eight total) as needed.
5. DO NOT create a closed loop from the last unit back to the first unit.

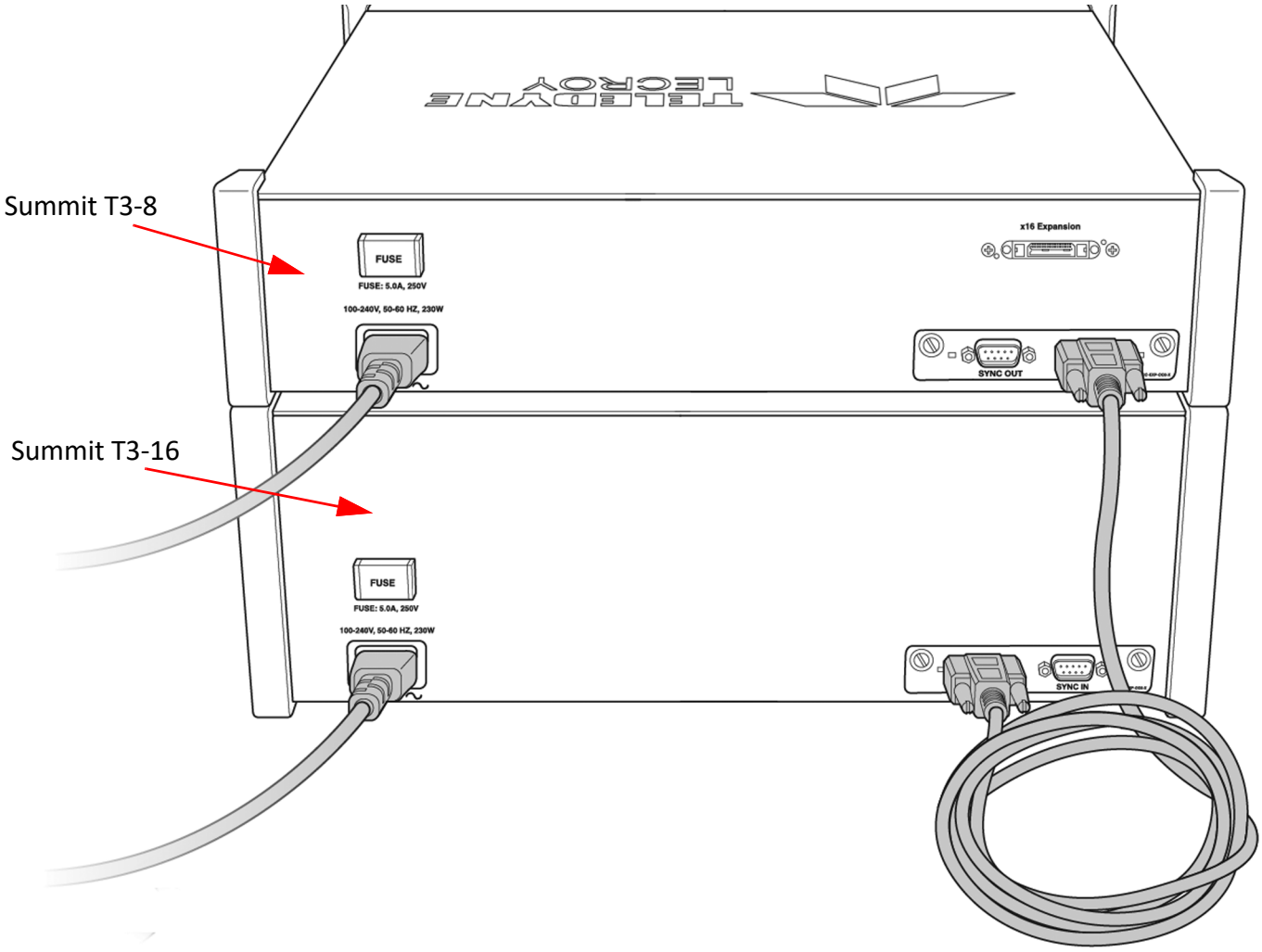


Figure 3.67: An Example of Connecting a Summit T3-8 to a Summit T3-16 Analyzer

3.8.2 CATC Sync Expansion Slots for Summit T3-16 and Summit T3-8

The expansion slot can be located on both the front panel and the rear panel for the Summit T3-16 and T3-8 Analyzers, so the first step is to determine which expansion slot to use, based on your system requirements and layout.

If you are removing a CATC SYNC expansion card see “Removal of CATC SYNC Expansion Cards” on page 142. If you are installing an expansion card continue with the steps below.

You can install expansion cards with a standard (flat blade) 3/16” screwdriver.

3.8.2.1 Installation of CATC SYNC Expansion Cards

1. Locate the blank expansion panel on either the front or the rear of the analyzer and then continue with the steps below.

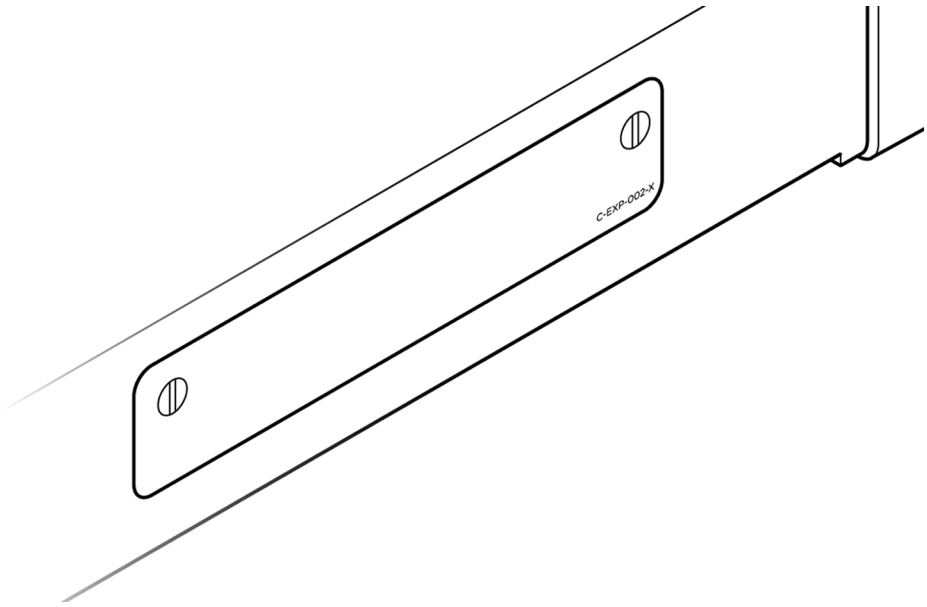


Figure 3.68: Front or Rear of Analyzer: Blank Panel

2. Using a flat bladed screw driver, loosen the two retaining screws.

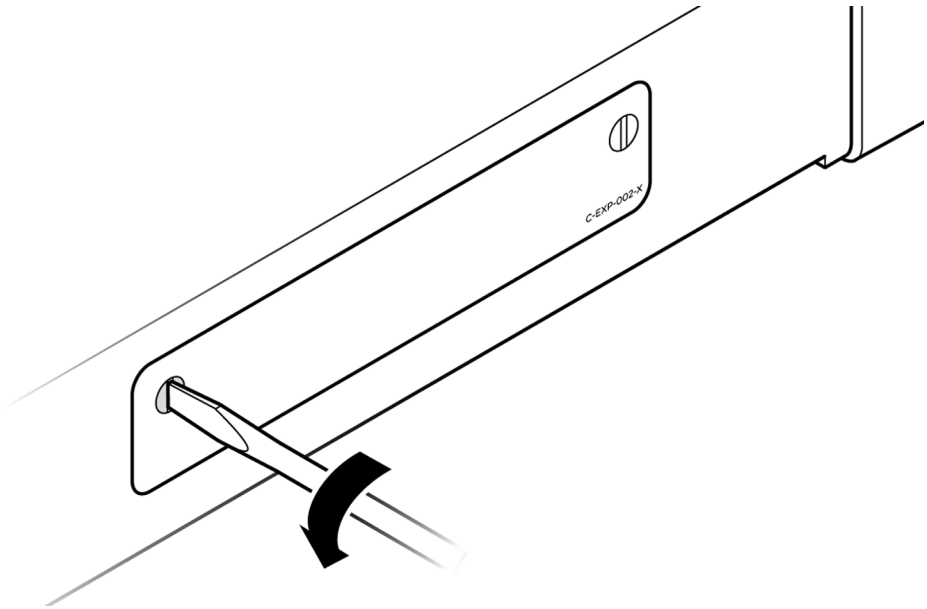


Figure 3.69: Loosen Retaining Screws from Blank Panel

3. Remove the retaining screws and blank panel, exposing the inside of the analyzer.

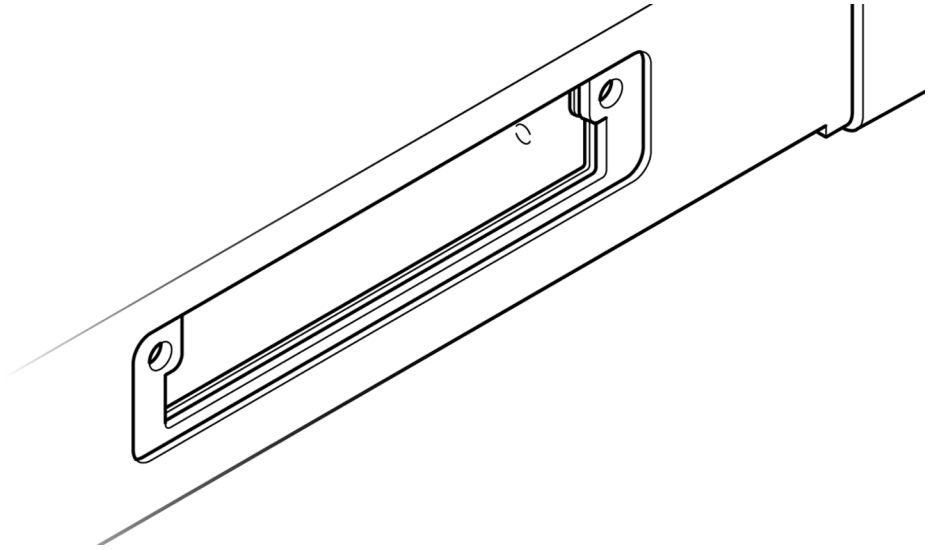


Figure 3.70: Rear of Analyzer with Blank Plate Removed

4. Insert the CATC SYNC card into the rear of the Analyzer. Gently push on the back panel of the card until you feel the card seat with the internal connector.

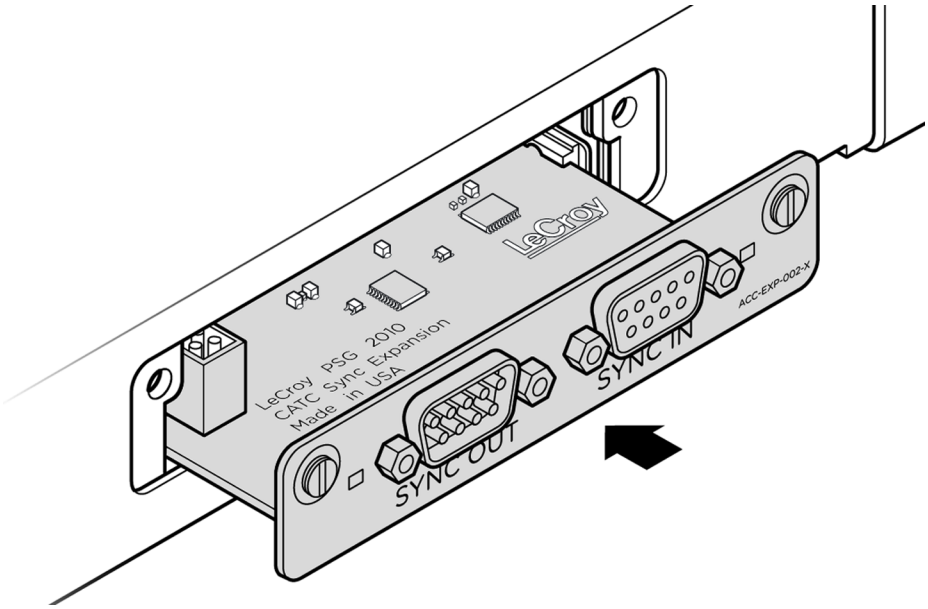


Figure 3.71: CATC SYNC Card Being Inserted into Rear of Analyzer

5. After the card is seated, tighten the retaining screws.

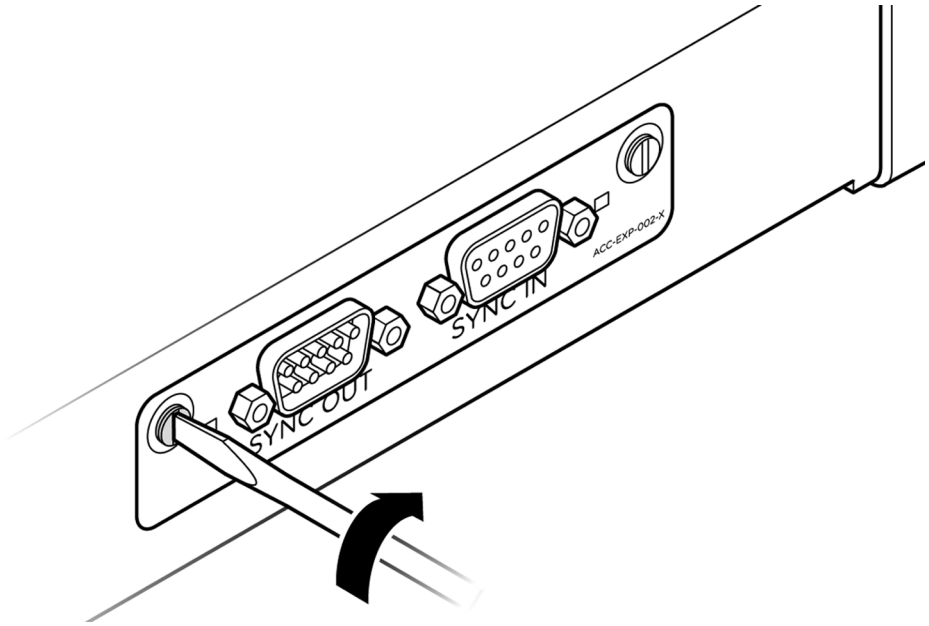


Figure 3.72: Tighten the Retaining Screws on the CATC SYNC Card

6. The CATC SYNC card can now be connected to other CATC SYNC cards in other analyzers. As described in the next section (“Daisy-Chaining with CATC SYNC Expansion Cards” on page 136).

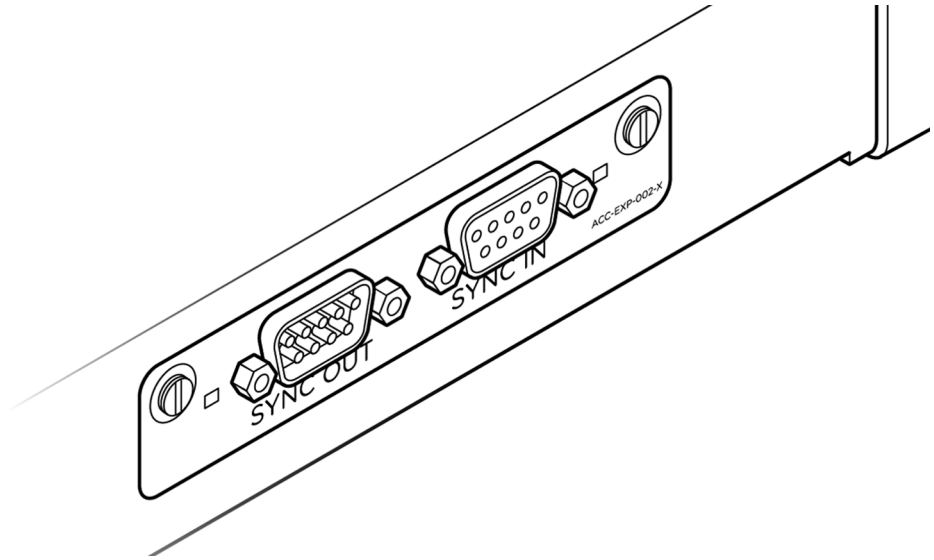


Figure 3.73: Analyzer with CATC SYNC Card Installed

3.8.2.2 Removal of CATC SYNC Expansion Cards

You can remove CATC SYNC expansion cards using two tools:

- Standard (flat blade) 3/16” screwdriver
- Teledyne LeCroy Extraction Tool (part number 230-0160-00)

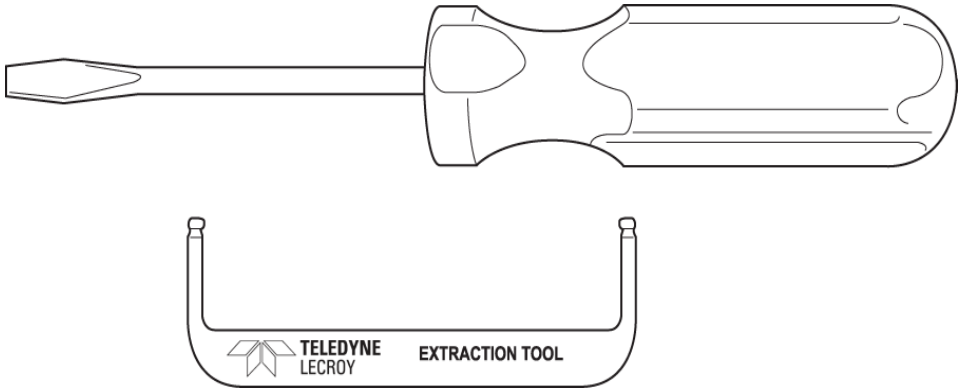


Figure 3.74: Tools needed to Remove the CATC SYNC Expansion Cards

To remove a CATC SYNC expansion card, follow these steps:

1. Unplug the system from AC power and turn the system so the expansion port is facing you.

Note: There are two retaining screws and the holes for the extraction tool that are located on the panel of the CATC SYNC expansion card. See Figure 3.75.

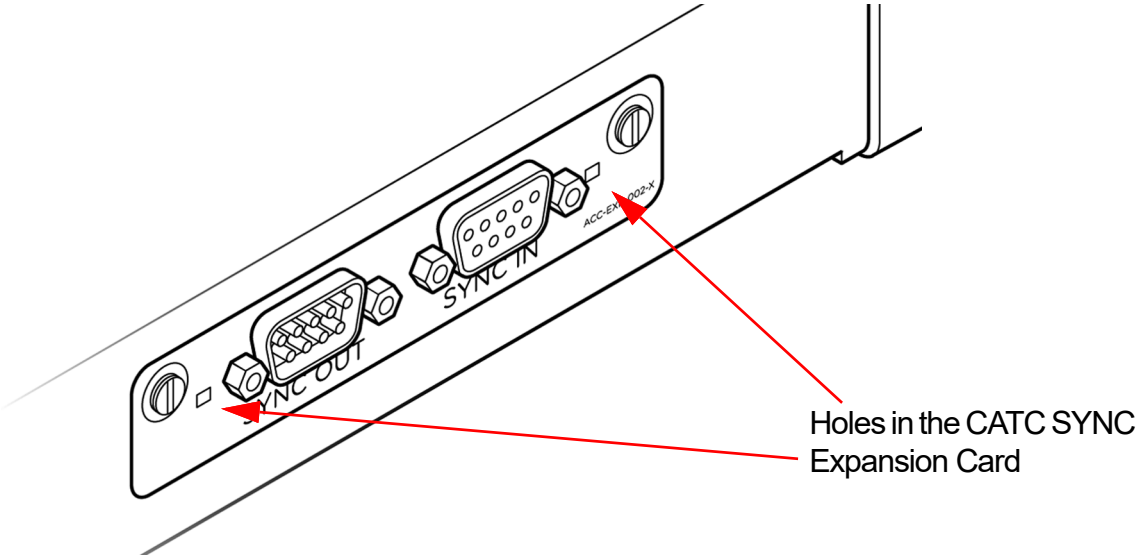


Figure 3.75: Holes in the CATC SYNC Expansion Card Panel

2. Using the screwdriver, loosen both retaining screws by rotating them counter-clockwise approximately two full turns, until feeling slight resistance. **Do not force the retaining screws** after two turns.

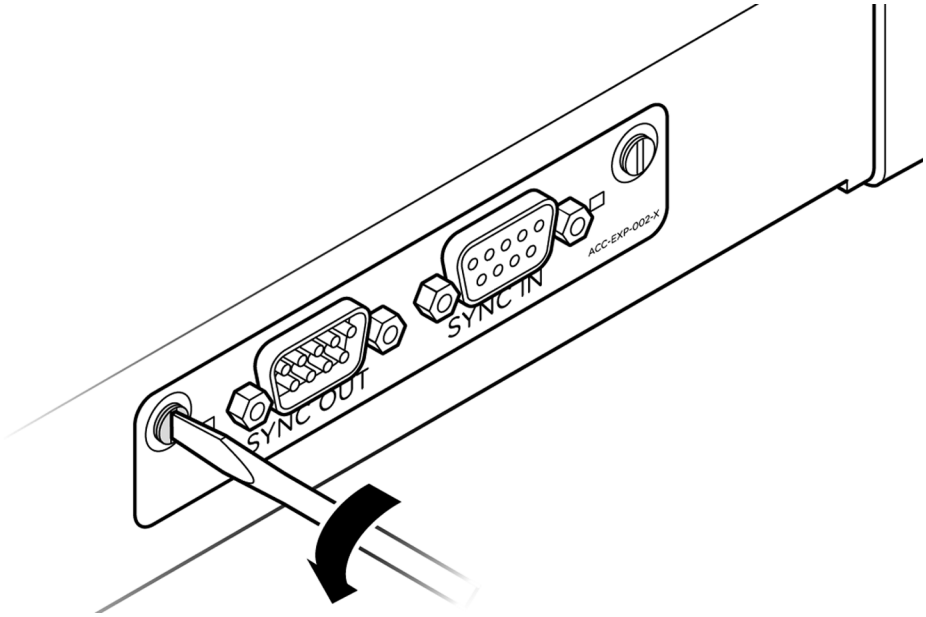


Figure 3.76: Loosen Retaining Screws on CATC SYNC Card

3. Insert the extraction-tool prongs into the holes in the CATC SYNC expansion card panel.

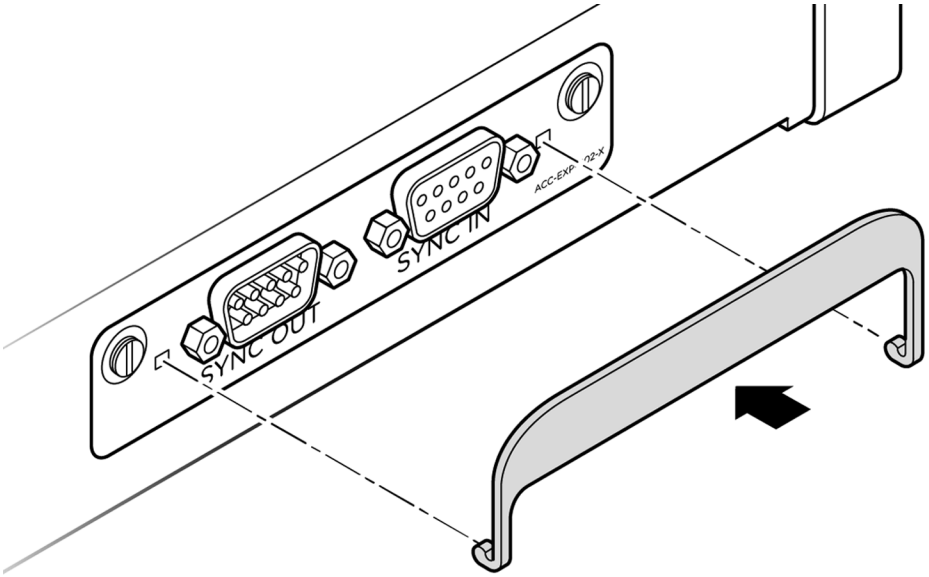


Figure 3.77: Insert Extraction Tool

Note: If the prongs do not slip easily into the holes, use a small nail file or similar device to remove paint from the prongs

4. Rotate the extraction tool to a horizontal position to lock the prongs into place and make a handle.

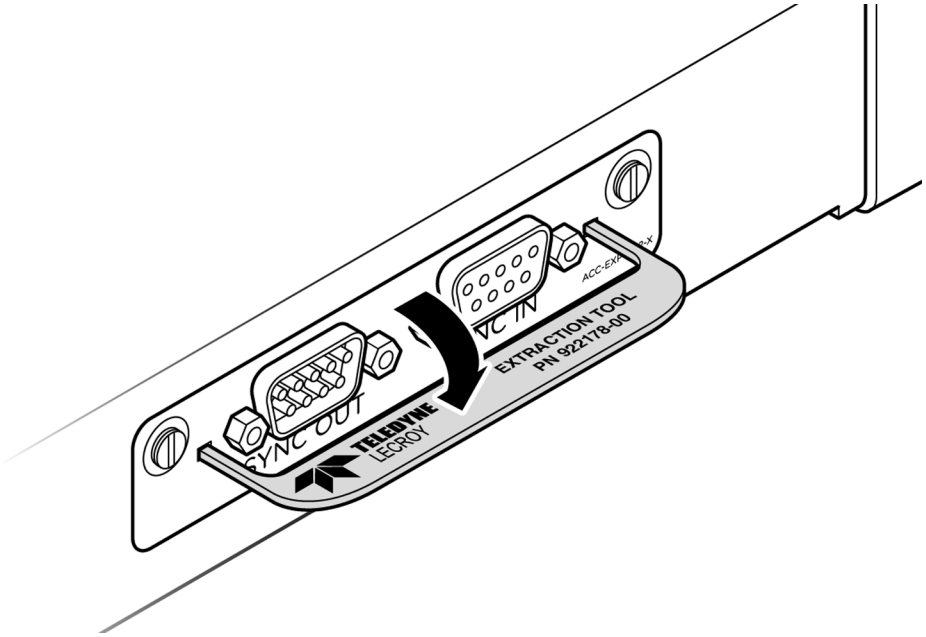
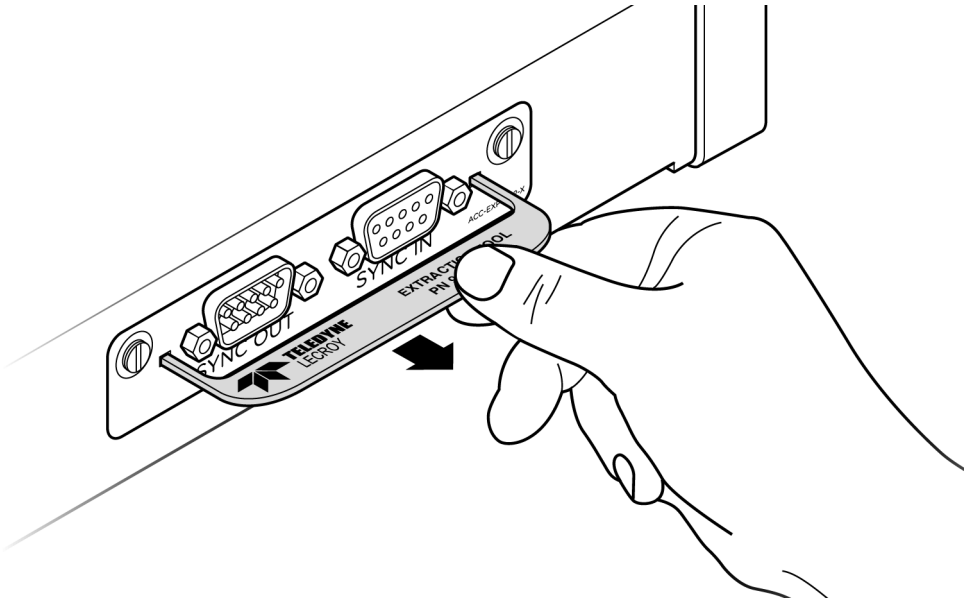


Figure 3.78: Insertion of Handle/Tool into CATC SYNC Expansion Card Panel

5. Using the extraction tool as a handle, gently wriggle the CATC SYNC expansion card forward about 1/8”.



6. Repeat step 5 approximately three times, until the CATC SYNC card is free from the retaining screws and you can remove the card from the system.
7. Replace the CATC SYNC Expansion Card with a blank panel and tighten the retaining screws. See Figure 3.79.

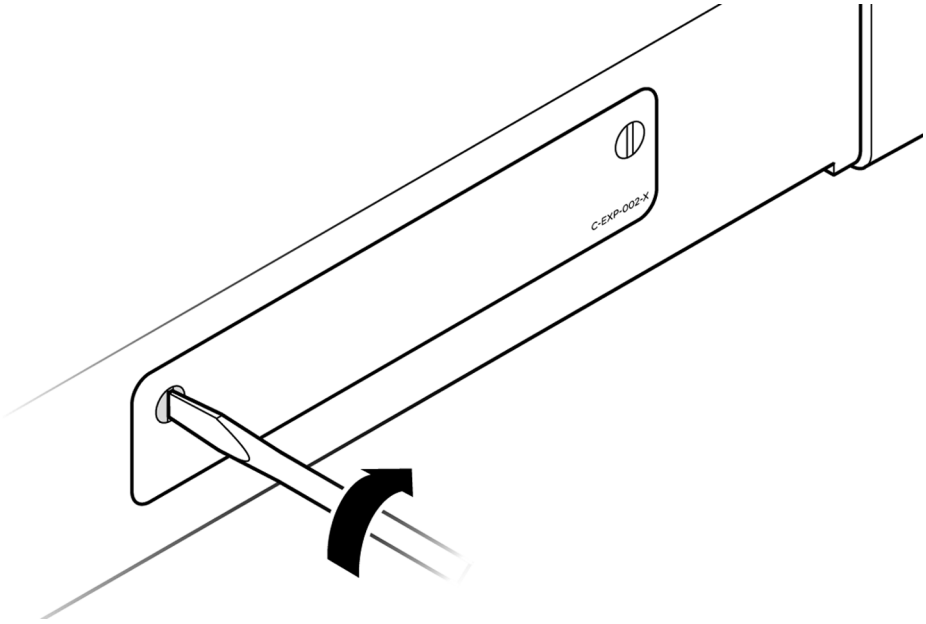


Figure 3.79: Replace Retaining Screws in Blank Panel and Tighten

3.8.3 CATC SYNC Time-Correlated Expandability (T34 and T24)

You can daisy-chain two Analyzers, if they both have a CATC SYNC port:

After Analyzers are connected, recording will start simultaneously and triggers will occur simultaneously, with synchronized timestamps.

You must select both Analyzers in the Device List dialog.

Important: If you are using other analyzers (NOT PCIe!) in your daisy chain (this would include USB, DDR, SAS, FC and GigE) and do not wish to use the daisy chaining feature of synchronized recordings, you must UNPLUG the cable! If you do not unplug, the electrical signal prevents recording on all Analyzers.

The Summit T34 and Summit T24 Analyzers have built in CATC SYNC functionality and can be connected to other analyzers through the 25 pin Sync/Data connectors on the rear panel (see Figure 3.80, Figure 3.81 and Figure 3.82 on page 147).

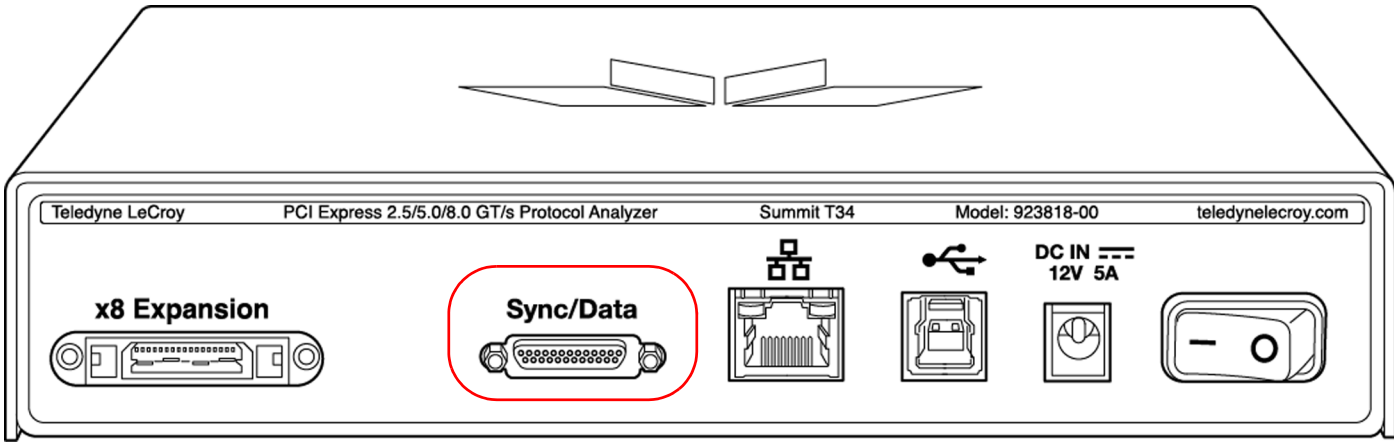


Figure 3.80: Summit T34 Analyzer Sync/Data Connector on Rear Panel

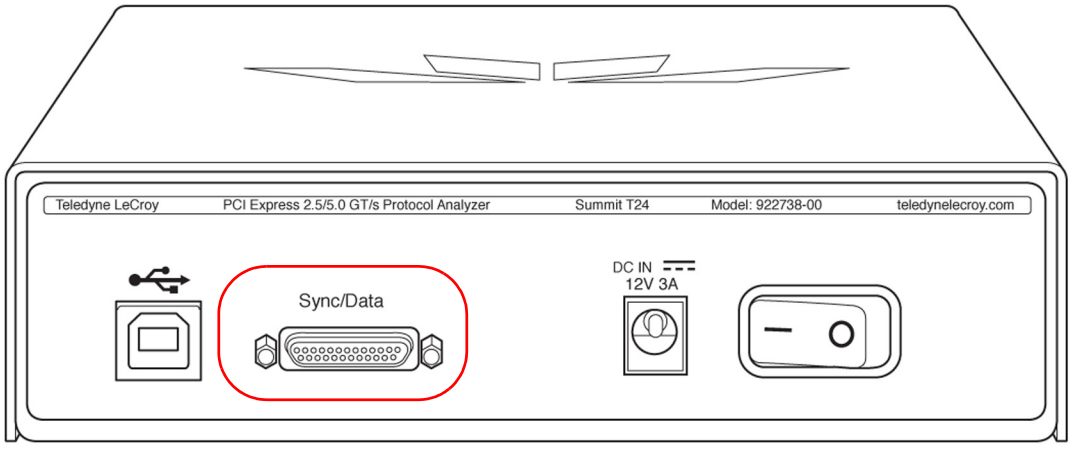


Figure 3.81: Summit T24 Analyzer Sync/Data Connector on Rear Panel

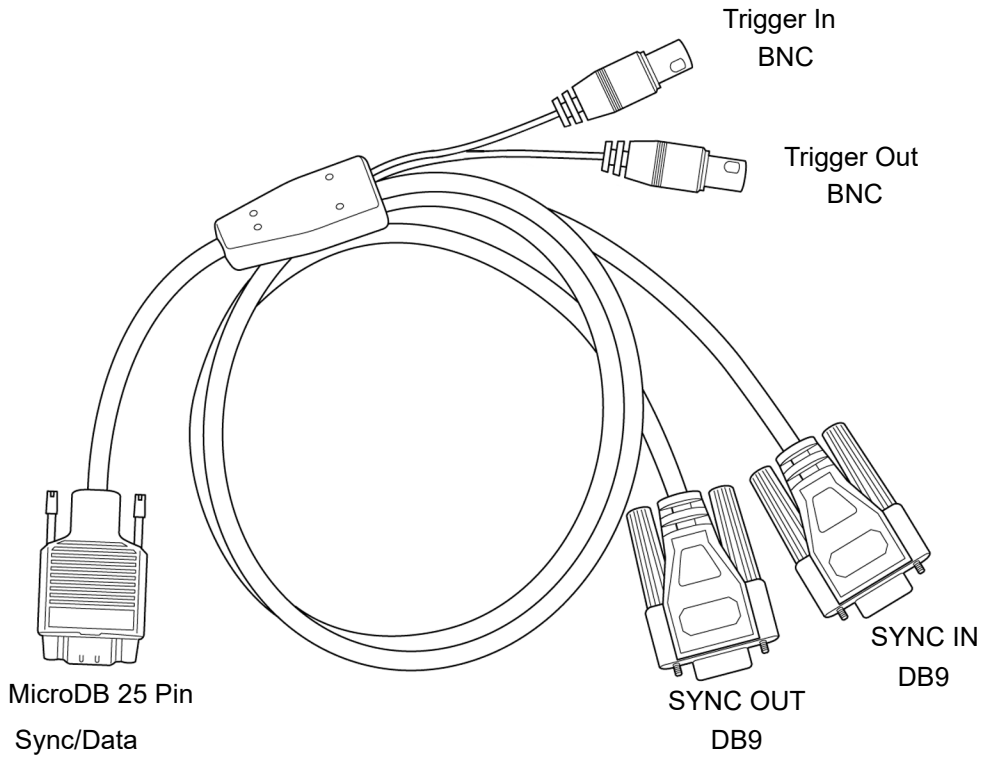


Figure 3.82: CATC SYNC Cable for Summit T34 or T24 Analyzer (AC030XXA-X)

3.8.4 CATC SYNC Time-Correlated Expandability with Two T34 systems

You can daisy-chain two Summit T34 Analyzers using the CATC Sync/Data port.

Connect the MicroD CATC Sync cable to the Sync/Data port on the two T34 systems (see Figure 3.83). After Analyzers are connected, recording can start simultaneously and triggers will occur simultaneously, with synchronized timestamps.

You must select both Analyzers in the Device List dialog (see Figure 3.13 on page 82).

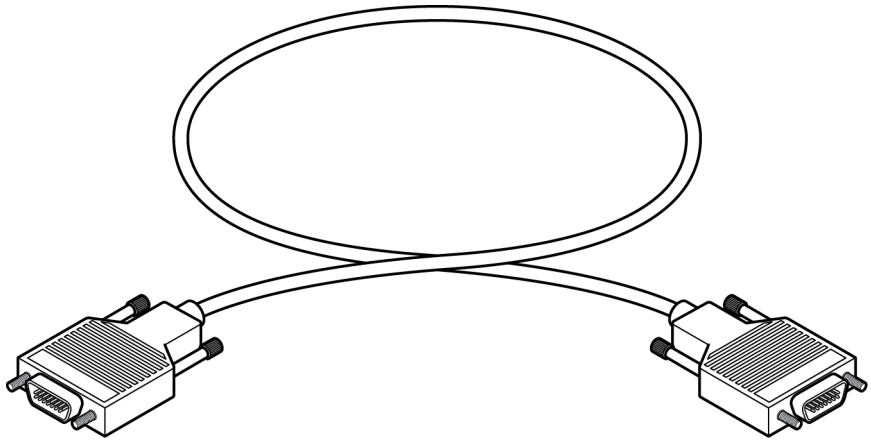


Figure 3.83: MicroD CATC Sync Cable

Important: If you are using other analyzers (NOT PCIe!) in your daisy chain (this would include USB, DDR, SAS, FC and GigE) and do not wish to use the daisy chaining feature of synchronized recordings, you must UNPLUG the cable! If you do not unplug, the electrical signal prevents recording on all Analyzers.

3.8.5 CATC SYNC Time-Correlated Expandability with Summit T28

You can daisy-chain two Analyzers, if they both have a CATC SYNC port:

After Analyzers are connected, recording will start simultaneously and triggers will occur simultaneously, with synchronized timestamps.

You must select both Analyzers in the Device List dialog.

Important: If you are using other analyzers (NOT PCIe!) in your daisy chain (this would include USB, DDR, SAS, FC and GigE) and do not wish to use the daisy chaining feature of synchronized recordings, you must UNPLUG the cable! If you do not unplug, the electrical signal prevents recording on all Analyzers.

3.8.5.1 CATC SYNC Daisy-Chaining the Summit T28 with other Analyzers

The Summit T28 Analyzer has built in CATC SYNC functionality and can be connected to other analyzers through the 9 pin Sync In or Sync Out connector on the rear panel (see Figure 3.84) with a single DB9 to DB9 cable.

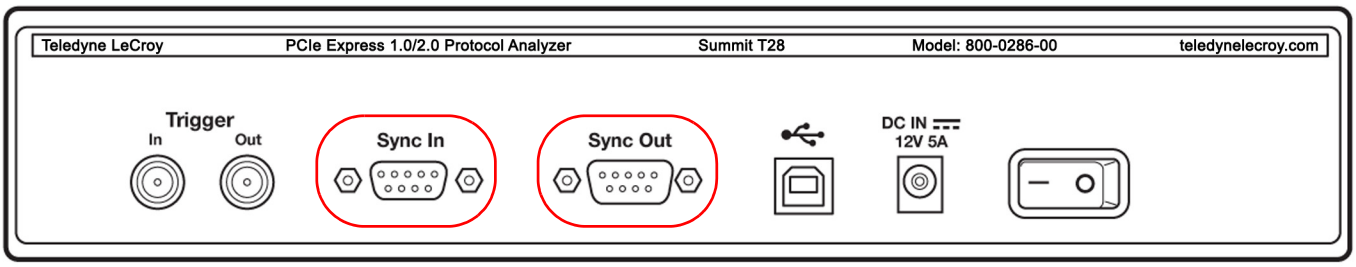


Figure 3.84: Summit T28 Analyzer with Sync In and Sync Out Connectors on Rear Panel

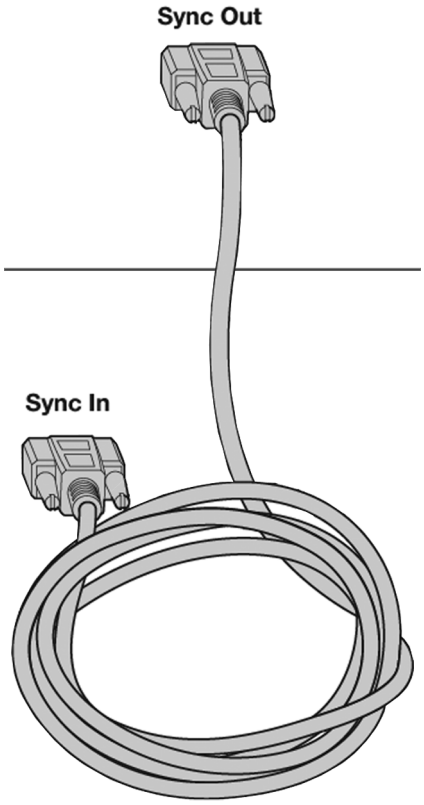


Figure 3.85: DB9 to DB9 CATC SYNC Cable Between Two Analyzers

3.8.6 CATC SYNC Time-Correlated Expandability with Summit T24

You can daisy-chain two Analyzers, if they both have a CATC SYNC port:

After Analyzers are connected, recording will start simultaneously and triggers will occur simultaneously, with synchronized timestamps.

You must select both Analyzers in the Device List dialog.

Important: If you are using other analyzers (NOT PCIe!) in your daisy chain (this would include USB, DDR, SAS, FC and GigE) and do not wish to use the daisy chaining feature of synchronized recordings, you must UNPLUG the cable! If you do not unplug, the electrical signal prevents recording on all Analyzers.

3.8.6.1 CATC SYNC Daisy-Chaining the Summit T24 with other Analyzers

You can daisy-chain the T24 with other Teledyne LeCroy equipment using a special cable with a DB25 connection to the Sync/Data port on the back of the T24 (see Figure 3.86) and DB9 connectors that go to the Sync/Data ports of other analyzers.

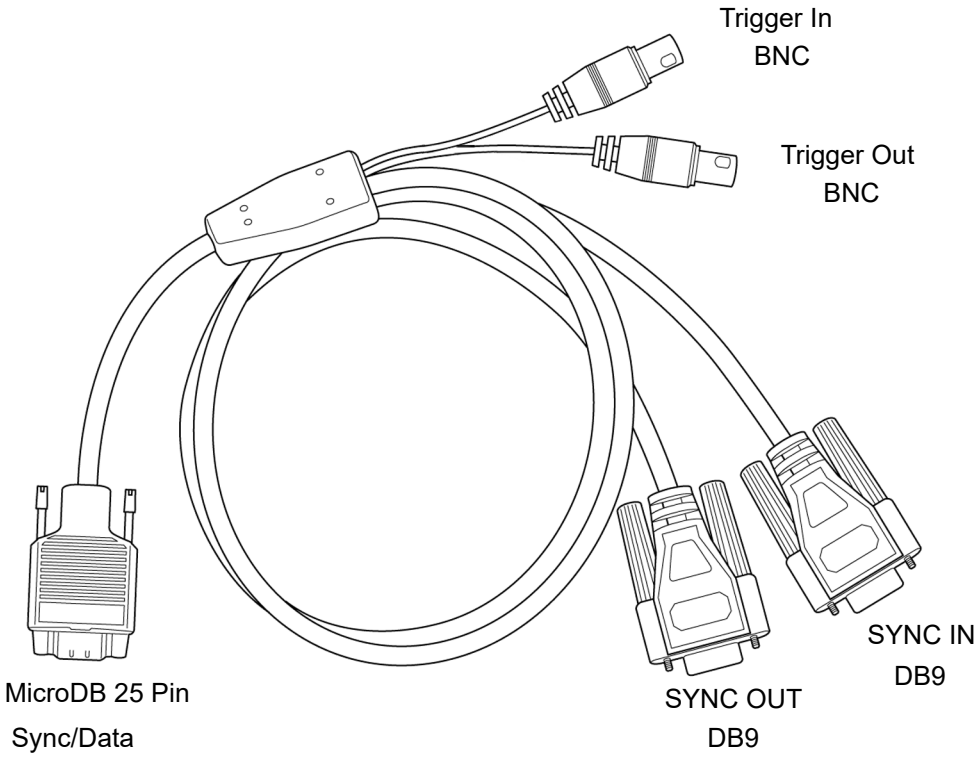


Figure 3.86: MicroD to CATC Sync Cable (AC030XXA-X)

3.9 Link Width Expansion Using Identical Analyzers

Another type of expansion, which can be implemented with either two Summit T3-8 or two T34 Summit Analyzers, can double the link width of the combined analyzers.

Two Summit T3-8 analyzers can be combined to form a single device with a link width of 16 bits.

Two Summit T34 analyzers can be combined to form a single device with a link width of 8 bits.

3.9.1 Two Summit T3-8s Configured in Link Width Expansion Mode

You can setup two Summit T3-8 analyzers to work together as one analyzer, in Expansion Mode, to support x16 recording capability. See Figure 3.87.

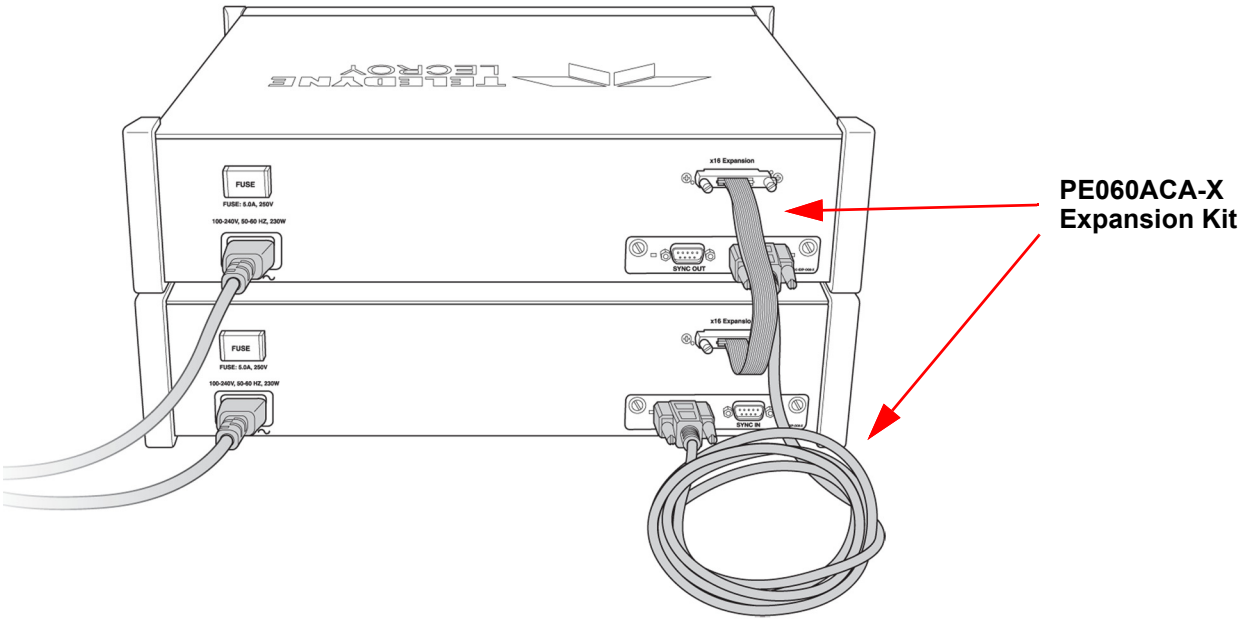


Figure 3.87: Two T3-8 Set Up in Expansion Mode

To set up the hardware configuration, both analyzers must have a CATC-Sync card plugged into a front or back expansion slot. Then perform the following steps:

1. Before setting up the hardware configuration, turn power off on both analyzers.
2. Using a CATC-Sync Cable, connect the Sync-Out connector on the CATC-Sync card of one Summit T3-8 analyzer to the Sync-In connector on the CATC-Sync card of the second Summit T3-8 analyzer.
3. Using an x16 Expansion Cable, connect the Expansion connector on the back of one Summit T3-8 analyzer to the Expansion connector on the back of the other Summit T3-8 analyzer.
4. Connect both analyzers to the host machine that has the PCIe Protocol Analysis application.

5. After completing the hardware configuration, power on both Summit T3-8 analyzers.
6. Open the PCIe Protocol Analysis application on the host machine.

   The software automatically detects and configures the analyzers to work as one x16 - capable analyzer. One Summit T3-8 analyzer is assigned the Upstream direction, and the other analyzer is assigned the Downstream direction. The LCD display on the front of each analyzer displays its direction assignment.

Standalone Mode

To reconfigure a Summit T3-8 analyzer to work alone, in Standalone Mode, first turn power off to the analyzer.

Disconnect the CATC Sync and Expansion cables from the analyzer.

After completing the hardware configuration, power on the Summit T3-8 analyzer.

Note: When operating two Summit T3-8 analyzers in X16 Expansion Mode, neither the TLP Payload nor the storage protocol triggers (NVMe, AHCI, ATA) are available for selection in the sequencer

3.9.2 Two Summit T34s Configured in Link Width Expansion Mode

You can set up two Summit T34 analyzers to work together as one analyzer, in Expansion Mode, to support x8 recording capability (see Figure 3.88 on page 153, Figure 3.89 on page 154 and Figure 3.90 on page 155).

To set up the hardware configuration, perform the following steps:

1. Before setting up the hardware configuration, turn power off on both analyzers.
2. Using a MicroD CATC-Sync Cable, connect the Sync/Data port from one Summit T34 analyzer to the Sync/Data port connector of the second Summit T34 analyzer.
3. Using a x8 Expansion Cable, connect the Expansion connector on the back of one Summit T34 analyzer to the Expansion connector on the back of the other Summit T34 analyzer.
4. Connect both analyzers to the host machine that has the PCIe Protocol Analysis application.
5. After completing the hardware configuration, apply power to both Summit T34 analyzers.
6. Open the PCIe Protocol Analysis application on the host machine.
   - ❑ The software automatically detects and configures the analyzers to work as one x8 - capable analyzer.
   - ❑ One Summit T34 analyzer is assigned the Upstream direction, and the other analyzer is assigned the Downstream direction.
   - ❑ The Speed LEDs will illuminate on the appropriate side of each analyzer to indicate the direction in which each Summit T34 is recording. The Speed LED in one of the Summit T34 analyzers will illuminate only on the left side, to indicate the PCIe lanes are being recorded from the Upstream direction. The other T34 analyzer will have the Speed LED illuminating only on the right side, to indicate the PCIe lanes are recorded from the Downstream direction.

7. Connect an iPass Y cable between the x8 interposer and the T34 analyzers, making sure the part A of the Y cable is connected to the upstream direction (indicated as described in previous step) and the part B of the cable is connected to the downstream direction.

Note: When operating two Summit T34 analyzers in x8 Expansion Mode, neither the TLP Payload nor the storage protocol triggers (NVMe, AHCI, ATA) are available for selection in the sequencer.

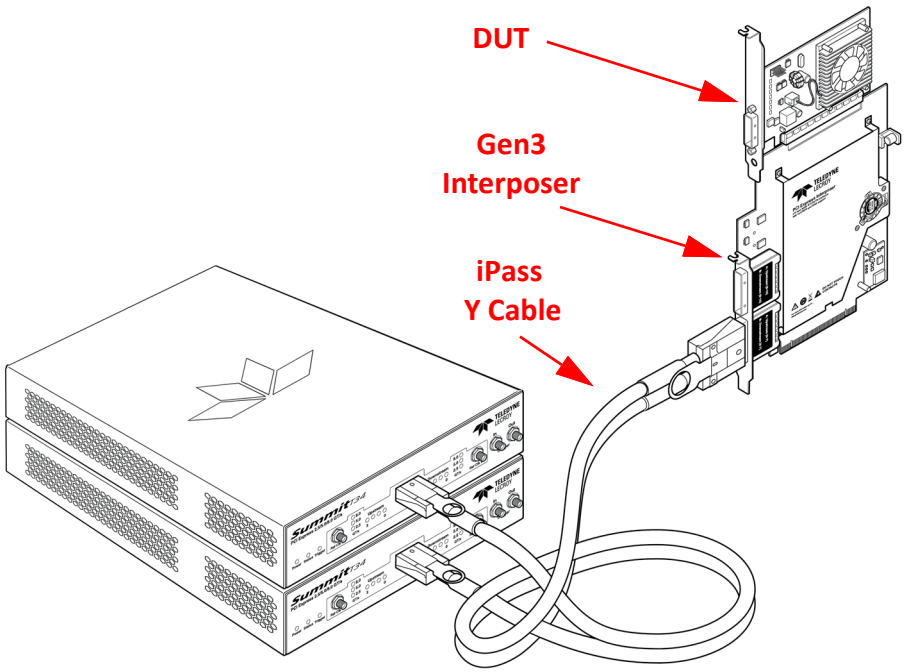


Figure 3.88: Expansion Mode - Front View.

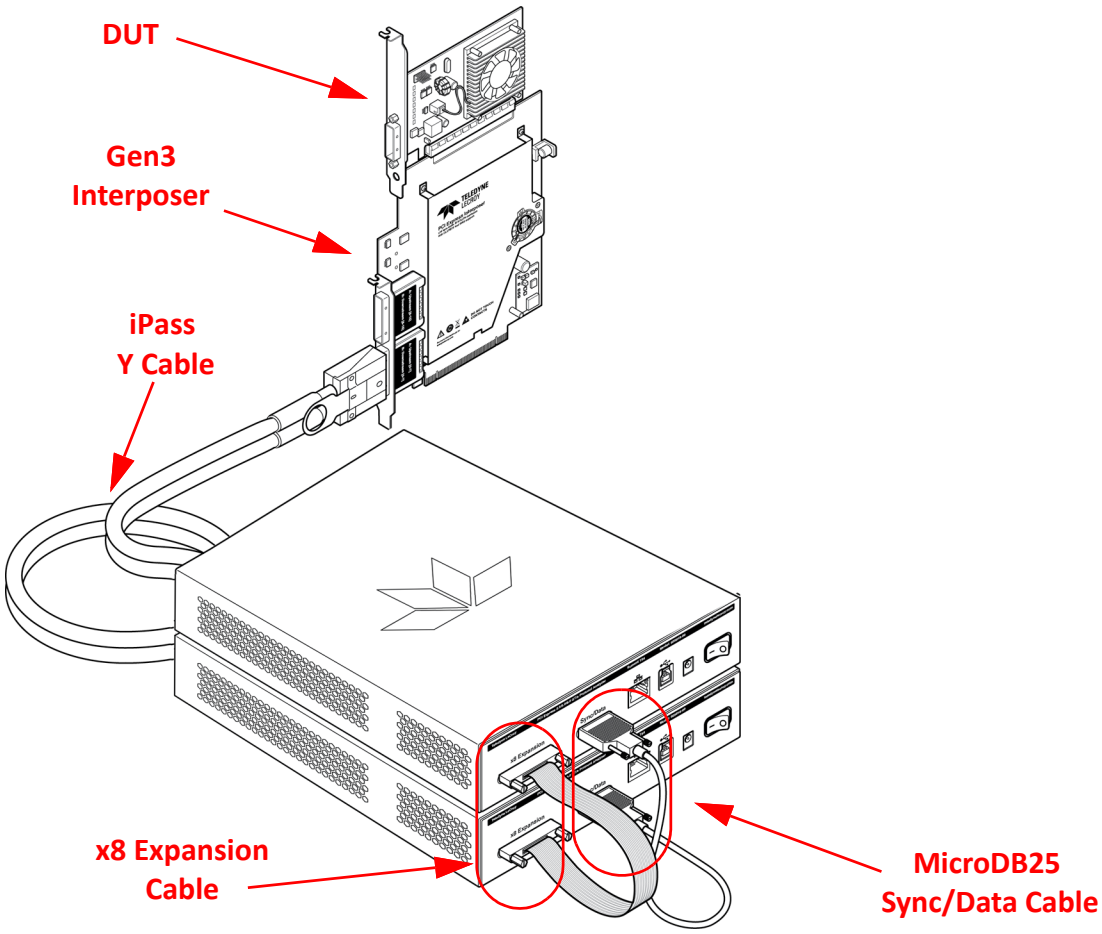


Figure 3.89: Expansion Mode - Back View.

3.9.2.1 Standalone Mode

1. To reconfigure a Summit T34 analyzer to work alone, in Standalone Mode, first turn power off to the analyzer.
2. Disconnect the MicroD Sync and Expansion cables from the analyzer.
3. After completing the hardware configuration, power on the Summit T34 analyzer.

Note: When operating two Summit T34 analyzers in x8 Expansion Mode, neither the TLP Payload nor the storage protocol triggers (NVMe, AHCI, ATA) are available for selection in the sequencer.

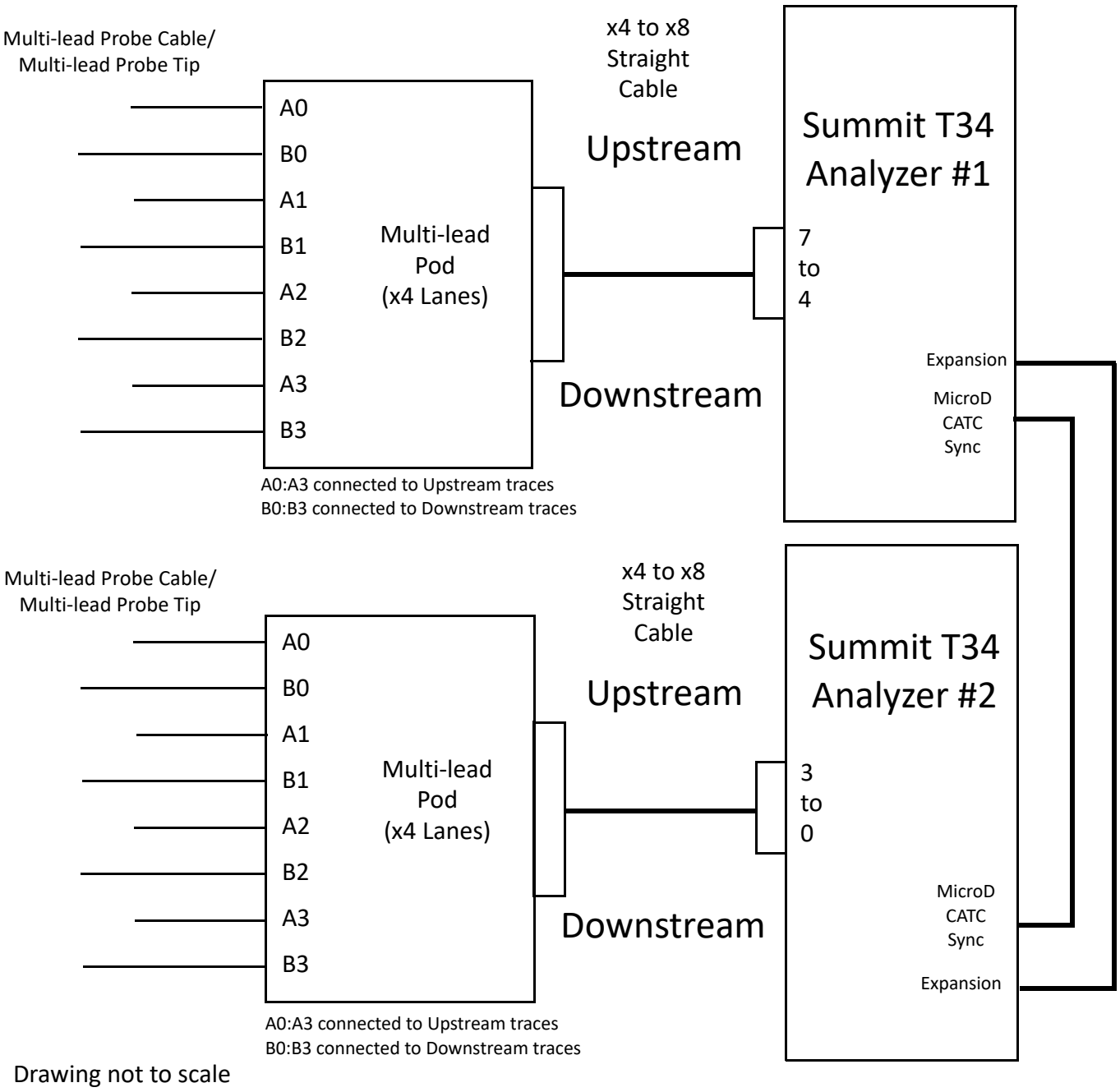


Figure 3.90: Interconnect Diagram: Two T34 Analyzers in Expanded Mode

3.9.3 Other Connection Options When Using MidBus or Multi-Lead Pods

See Figure 3.91 and Figure 3.92 on page 157 for details on different ways the Summit T34 and pods can be connected.

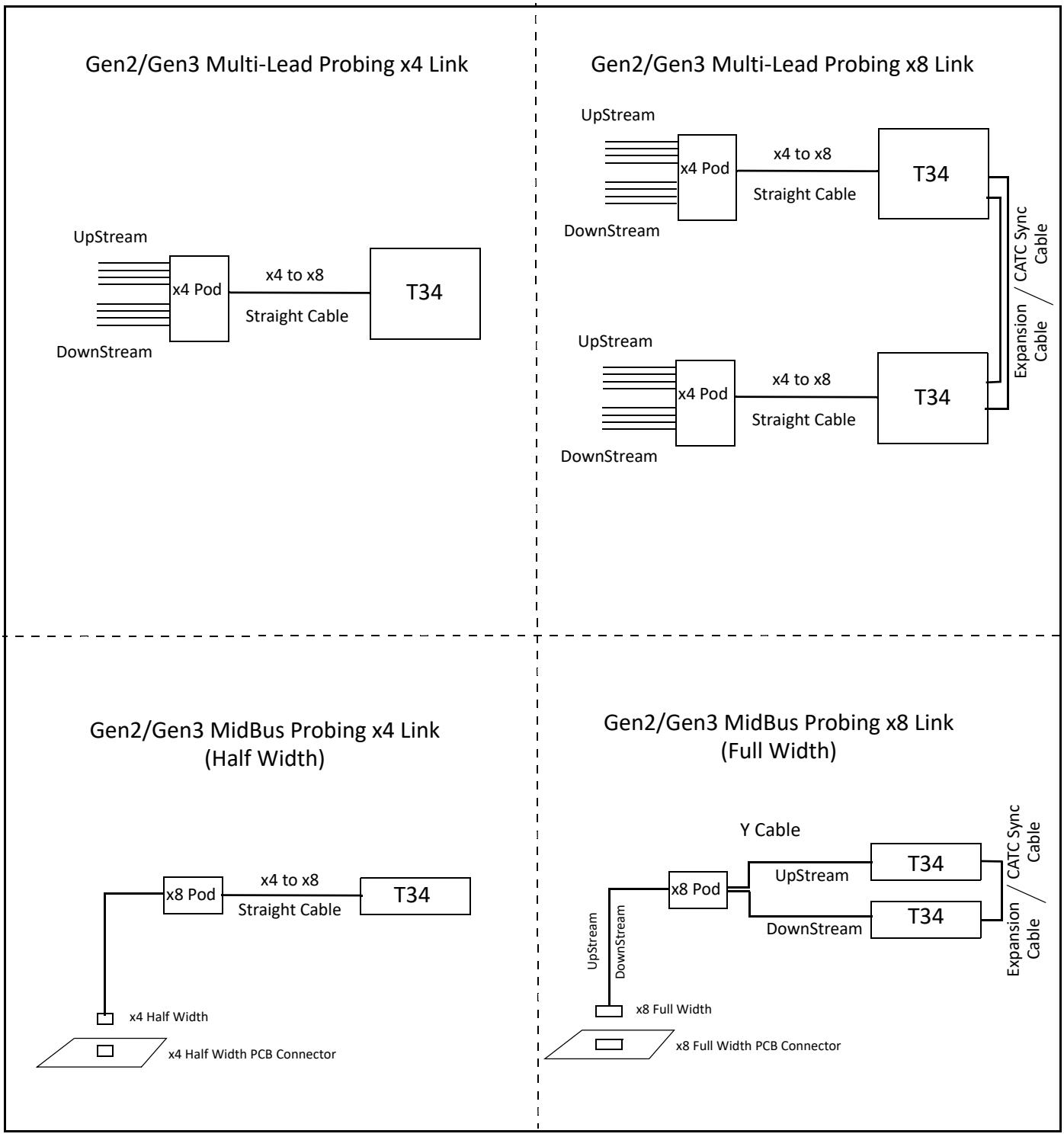


Figure 3.91: Summit T-34 Probe and Pod Configurations

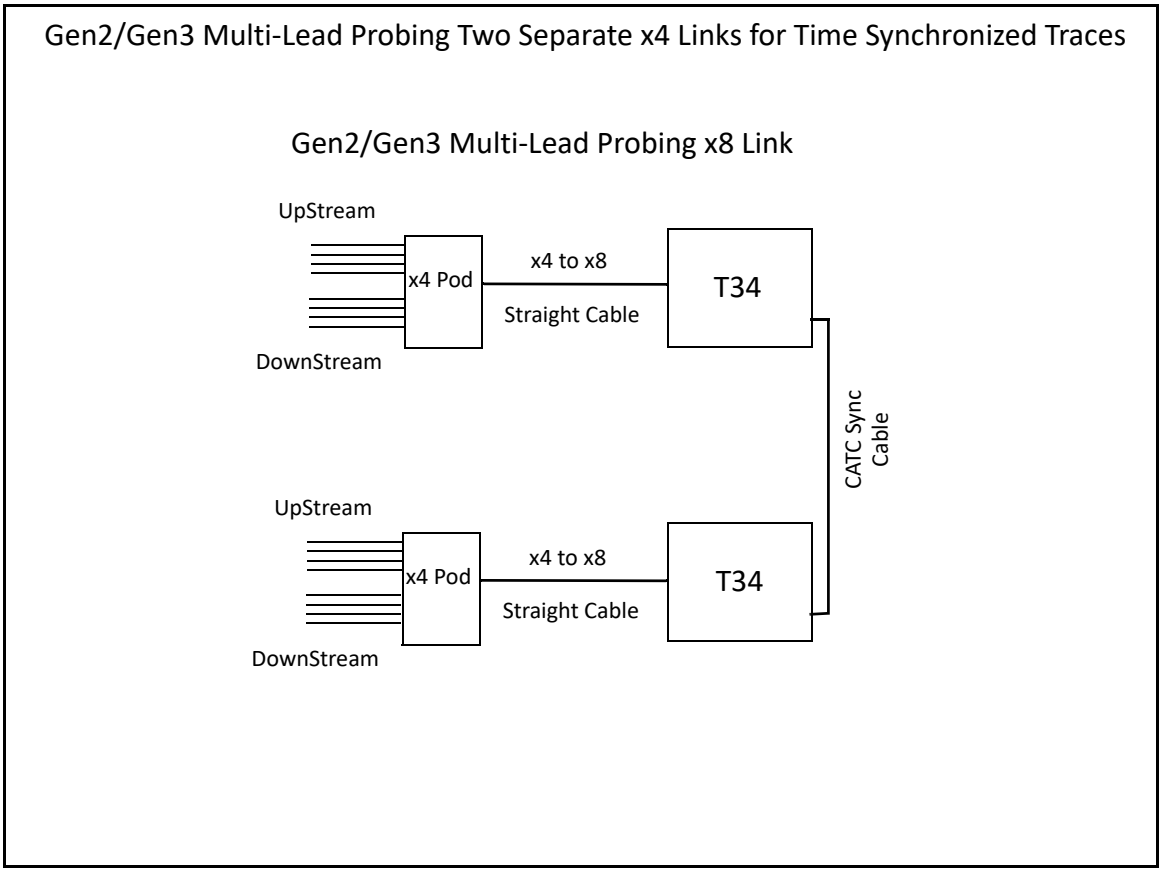


Figure 3.92: Using T34s With Time Synchronized Traces

3.10 Differences Between Summit Analyzers

Each Summit Analyzer has a variety of hardware or software differences. They are summarized below:

TABLE 3.2: Analyzer Features

	Summit Model Analyzer				
Feature	**T3-16**	**T3-8**	**T34**	**T28**	**T24**
iPass Y Data Cable	✓	✓	N/A	✓	N/A
iPass Straight Data Cable	N/A	N/A	✓	N/A	✓
NVMe Enhanced Mode Recording	N/A	N/A	✓	N/A	N/A
TLP Payload Match Resource (with Link Width = Auto x4) (Fixed and Floating)	8	8	8	6	N/A
Packet Matching Resource	8	8	8	6	6
Basic Resource	8	8	8	6	6
Support Real Time Statistics	✓	✓	✓	✓	N/A
Support Autoswizzle	✓	✓	✓	✓	Manual swizzle only

✓ = Included, N/A = Not Applicable

Chapter 4

Software Overview

4.1 The PCIe Protocol Analysis

The PCIe Protocol Analysis™ administers Analyzer platforms and handles all CATC Trace analysis and display. The core software is thus the same for all of Teledyne LeCroy's PCI Express products.

The software runs on a Windows® based host machine that is attached to the Analyzer via an Ethernet or USB connection. The T34 can use USB 3.0, all other analyzers use USB 2.0. PCIe Protocol Analysis can be used without the Analyzer as a CATC Trace viewer for viewing, analyzing and printing traces.

The PCIe Protocol Analysis operates on systems using Windows (refer to "Installing the PCIe Protocol Analysis software" on page 67 for more details).

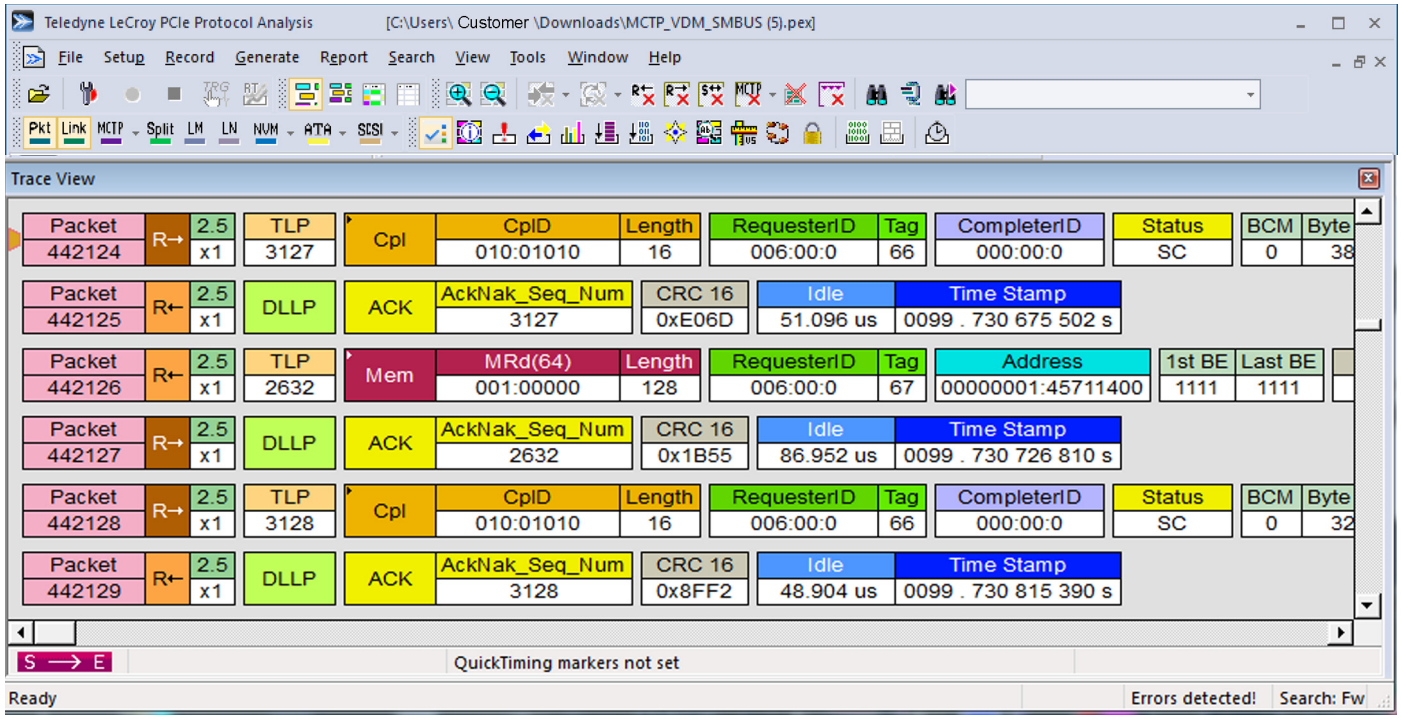


Figure 4.1: Sample of a CATC Trace

4.2 Application Layout

The PCIe Protocol Analysis application contains the following components:

Title bar: The title bar is at the top of the application window and displays the CATC Trace file name or generation script name.

Menu bar: The menu bar is located below the title bar, by default. The menu bar can be moved by clicking a blank area of the bar and then dragging the menu to a new position. It can be docked in another part of the application window or moved outside of the window to become a floating menu.

Toolbar: The toolbar is composed of buttons that represent the commonly used commands. The toolbar divides into smaller toolbars that can be moved and docked in a new position or made to float outside of the window.

Display area: The display area is the main part of the application window in which CATC Traces are displayed.

Status bar: The status bar is located at the bottom of the application window. The left end of the status bar displays descriptions of buttons and menu items when the mouse is positioned over them. The right end of the bar shows the search direction.

4.3 Using the Toolbar

You can use the PCIe Protocol Analysis application Toolbar as a shortcut to most of the operations supplied by the menus.

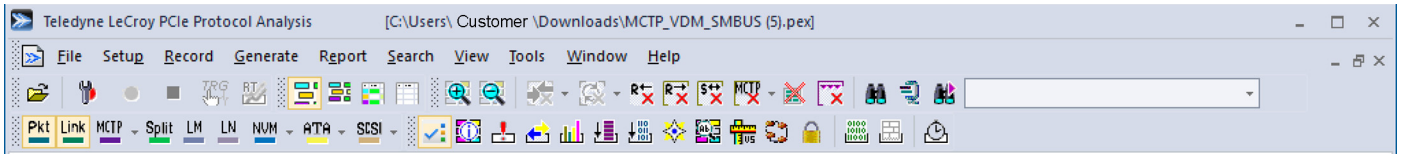
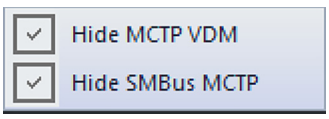


Figure 4.2: Summit T3 Toolbar

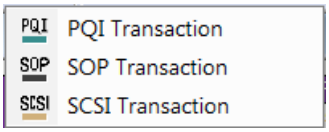
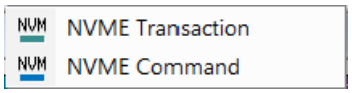
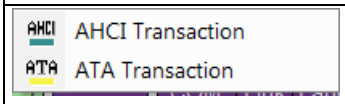
	Opens a previously recorded CATC Trace file.		Stop Recording.
	Setup Recording Options Opens the Recording Options dialog.		Real Time Statistics monitor Opens a window that displays real-time information.
	Start Recording.		

	Displays CATC Trace view.		Displays color spreadsheet view.
	Displays compressed CATC Trace view.		Displays black and white spreadsheet view.

	Zoom in display.		Advanced Hiding Options Opens a dialog box that allows you to select items to hide from view.
	Zoom out display.		Hide Unassociated Traffic Hides the lower-level transaction packets. Example: Link Transactions and Packets are considered “unassociated” when using Split Transaction Level view.

	Hide Training Sequence.		Compact View Toggles compacting of training sequences to analyze CATC Trace data faster, or no compacting to display more data.
	Hide SKIP and Update FC packets.		Find Opens a dialog box that allows you to select one or more items to find in the recording, then searches to that point.
	Hide Upstream recording/ traffic.		Find Next. Repeats last Find or Search action.
	Hide Downstream traffic/ recording.		Hide Sideband traffic.
	Hide MCTP VDM and Hide SMBus MCTP		
			

	Quick Search window: Allows user to search for pre-defined terms or type in their own term to search for. See “Quick Search Feature” on page 178.

	View Packet Level data.		View Link Transaction Level data.
	View Split Transaction Level data		View PQI, SOP and SCSI Transaction Level data pull down menus.
	View NVME Transaction Level and Command data pull down menus		
			View MCTP Transaction Level data
	View AHCI and ATA Transaction Level data pull down menus		Lightweight Notification Transaction Level data
			

	Trace Expert Generates data on Performance Analysis, Trace Analysis Statistics, Error Reports and Trace Information.		Opens the Data Flow window. Shows recorded data in a compressed tabular format.
	Trace Information Lists the conditions under which the recording was made.		Navigator. Shows/hides the Navigator bar - a utility that lets you easily navigate the CATC Trace

	Error Report Opens a window that lists all errors identified in the recording.		Detail View Shows the Detail view of the selected packet.
	Traffic Summary Opens a window that lists all events that occurred during the recording		Running Verification Scripts Runs selected Verification Scripts
	Bus Utilization Opens a window that graphically represents various information about the recording.		LTSSM Flow Graph Shows a state diagram of the Link Training and Status State machine.
	Link Tracker Opens a window that displays symbol information per lane.		Opens view for TCG Security Codes. TCG decoding is performed using NVMe Command Level option.

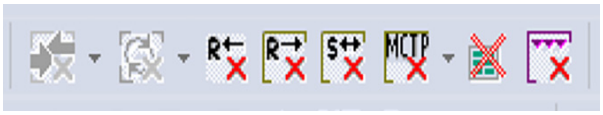
	Displays the Data/Payload window for the current packet.		Displays the Packet Header bar. Opens a window that displays the header information in the current packet, as it would be viewed in the specification.
	Opens the Timing and Bus Usage Calculations window.		

4.4 Multi-Segment Toolbar

	First Segment. Open first segment in the multisegment CATC Trace.		Index file. This button becomes active if a multisegment CATC Trace file is open and displays the index file for the recording.
	Previous segment. Open previous segment in the multisegment CATC Trace.		Next Segment. Open next segment in multisegment CATC Trace.
			Last segment. Open last segment in multisegment CATC Trace.

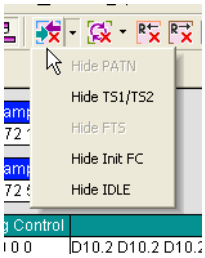
4.4.1 Toolbar Hide Buttons

The PCIe Protocol Analysis application toolbar has five buttons related to show/hide of CATC Trace file contents. The buttons allow you to quickly adjust the display to your needs.



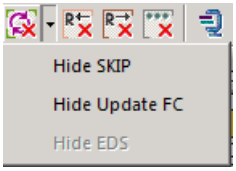


Hide Training: Brings up a drop-down menu that lets you to hide all or a portion of the packets in the training portion of the CATC Trace.





Hide SKIP, Update FC and Hide EDS: Brings up a drop-down menu that lets you hide SKIP, Update FC and hide EDS packets in a CATC Trace.



Hide Upstream: Hide all traffic from endpoint devices to the root complex.



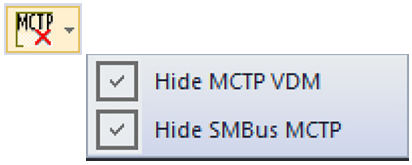
Hide Downstream: Hide all traffic from the root complex to endpoint devices.



Hide Sideband: Hide all sideband traffic (includes SMBus traffic).



Hide MCTP: Hide MCTP VDM traffic (and/or) Hide SMBus MCTP traffic.



Advanced Hiding Options: Brings up the Level Hiding pane of the Display Options window. Use this pane to tune the show/hide options within the CATC Trace display.



4.4.2 Display Options: Level Hiding -> Direction

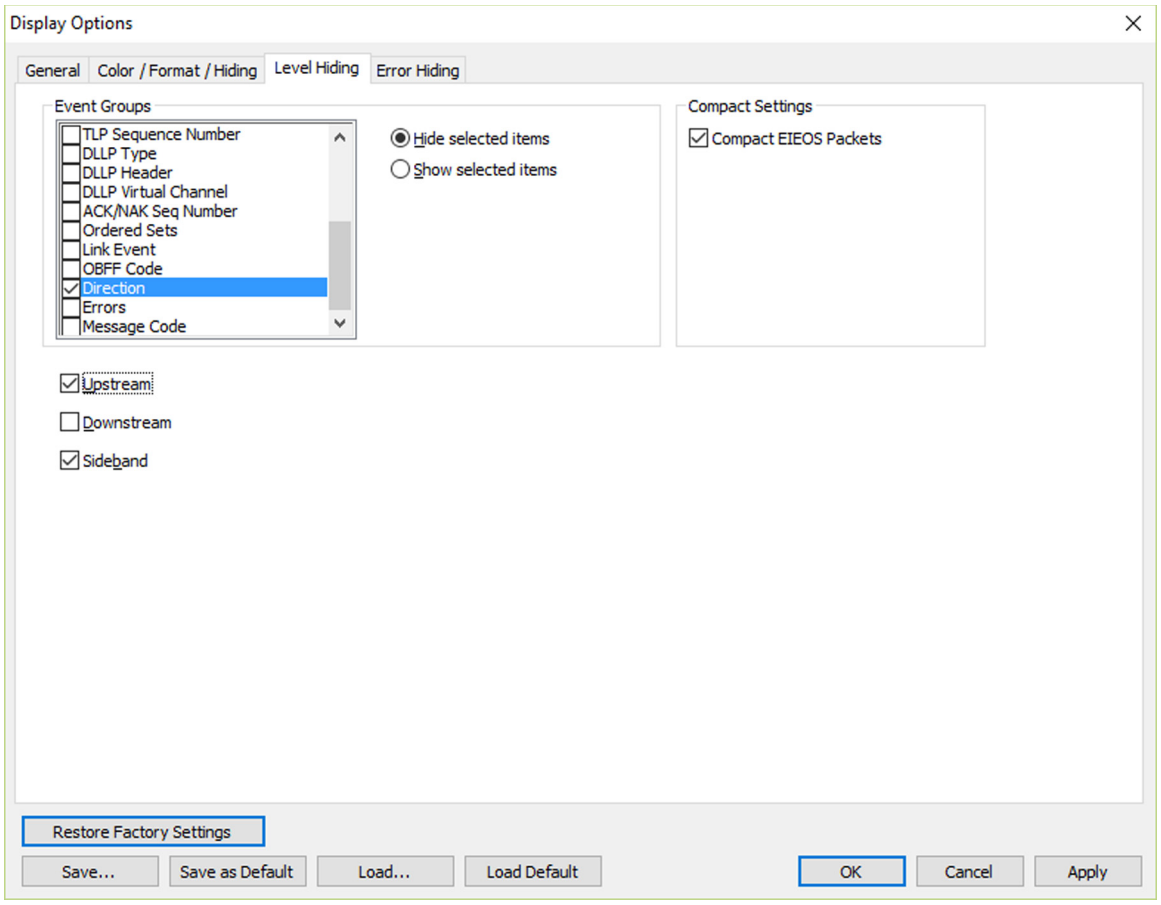


Figure 4.3: Display Options

You can select the Direction of traffic to Hide:

- Upstream
- Downstream
- Sideband (includes SMBus traffic)

Hide Unassociated Traffic: Hides the lower-level transaction packets. Example: Link Transactions and Packets are considered "unassociated" when using Split Transaction Level view.



4.5 Using the Menus

The PCIe Protocol Analysis application main display includes the following set of pull-down menus:

File Setup Record Generate Report Search View Tools Window Help

4.5.1 File Menu

New PETrainer Script	Creates a new Traffic Generation file.
Open	Opens a file.
Close	Closes the current file.
Save as	Saves all or a specified range of packets to a uniquely named file. Overwrites existing file name. See “Using the Save As Function” on page 196.
Save Copy As	Saves all or a specified range of packets to a uniquely named file. Original file remains the same and new file is created with the new file name. See “Save Copy As Function” on page 198.
Convert Old Files	Convert CATC Trace files made in previous versions of PE*Tracer* to the new format for PE*Tracer* version 5.0 and higher.
Print	Prints part or all of the current traffic data file.
Print Preview	Produces an on-screen preview before printing.
Print Setup	Setup your current or new printer.
Clean Up Decoder Temp Files	Let’s you selectively delete decoder temp files (see “Clean Up Decoder Temp Files” on page 169).
Edit Comment	Create or edit the comment field in a CATC Trace file.
Export >> to Text >> Packets to CSV Text >> to Generator File Format	Saves all or part of a CATC Trace to a text file or traffic generation file. This text file summarizes the traffic in the CATC Trace. Saves the CATC Trace to a text file in Comma Separated Value (CSV) format. Saves the CATC Trace to a generation file, which can be used Summit Exerciser (Z3-16).
Exit	Exit the PCIe Protocol Analysis application.

4.5.1.1 File Dialog

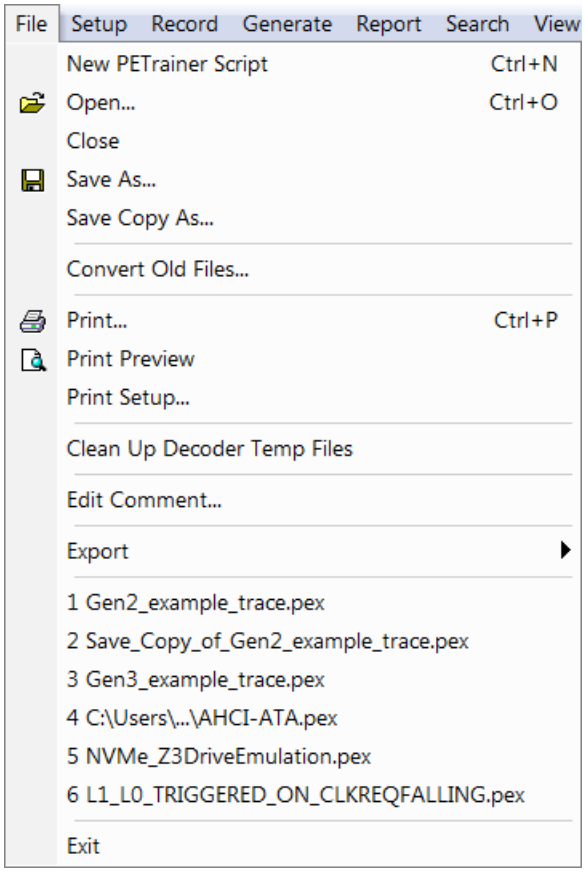


Figure 4.4: File Dialog

4.5.1.2 Clean Up Decoder Temp Files

This command deletes selected decoder temp files from the selected folder.

The file types effected by this command are:

- *.pem
- *.pex
- *.peraw
- *.mpex
- *.peg

To use this command follow the steps below:

1. The Sample File Folder has Temp files for every trace that has been opened: See Figure 4.5.

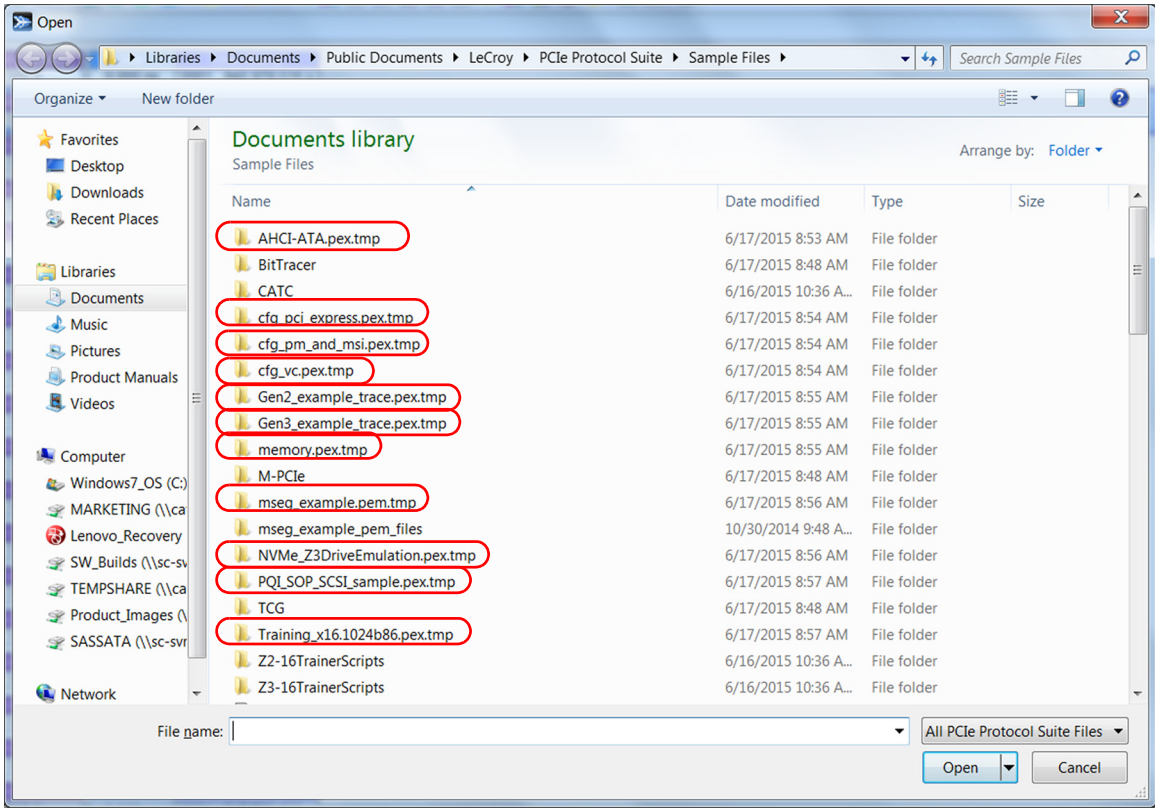


Figure 4.5: Sample Files Folder After Opening a Variety of Traces

2. Now select the File -> Clean Up Decoder Temp Files (see Figure 4.4 on page 168).
3. The following Dialog will pop up: See Figure 4.6 on page 170.

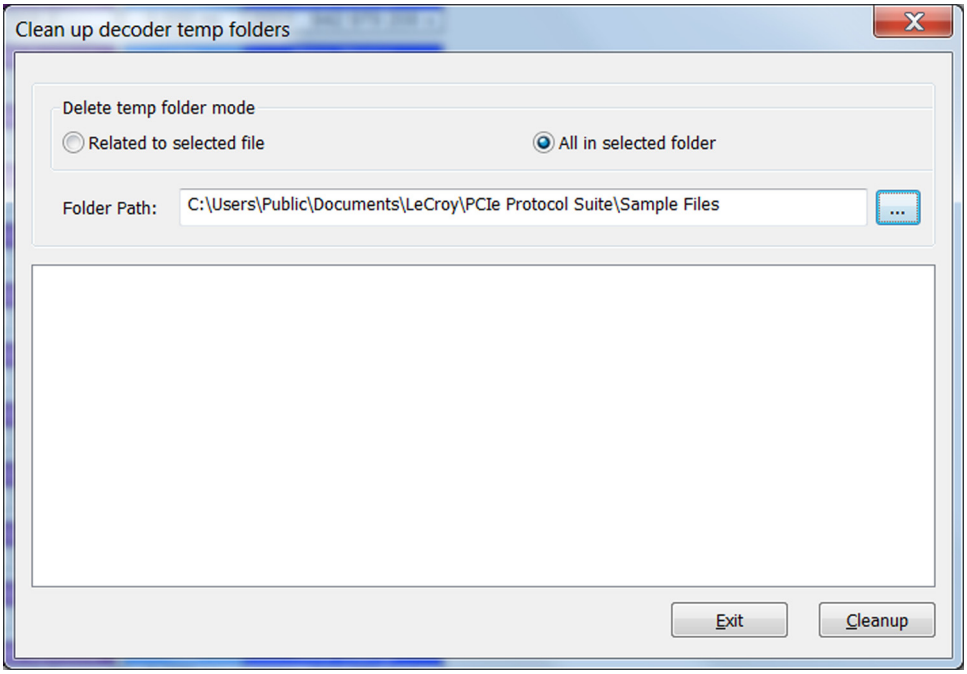


Figure 4.6: Clean Up Decoder Temp Files Dialog

4. Select C:\Users\Public\Documents\LeCroy\PCIe Protocol Site\Sample Files folder.
5. Select Cleanup and a Warning Dialog will pop up. See Figure 4.7.

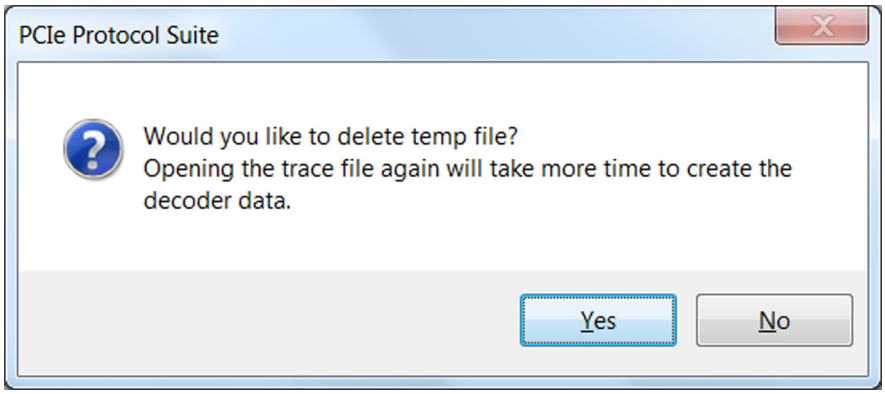


Figure 4.7: Clean Up Decoder Temp Files Warning Dialog

6. Click on Yes, (if files are still in use the Clean Up will Fail, see Figure 4.8 on page 171).

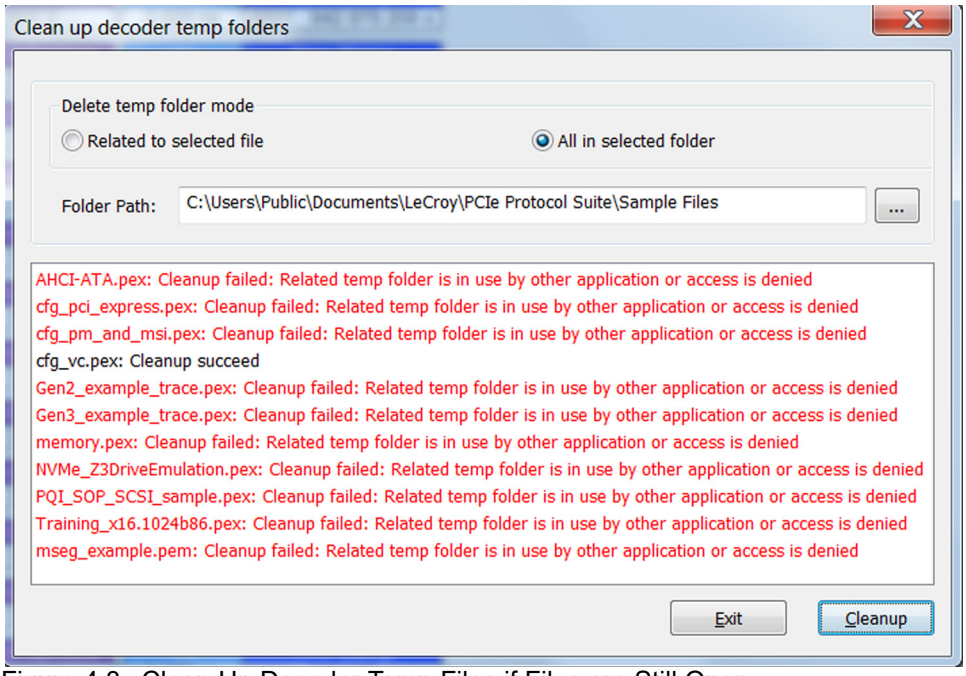


Figure 4.8: Clean Up Decoder Temp Files if Files are Still Open

7. Close Files you're not working with.
8. Select Clean Up Decoder Temp Files again.
9. Select Yes on the Warning Dialog.
10. With the files closed, the Clean Up Dialog will respond as shown below (see Figure 4.9).

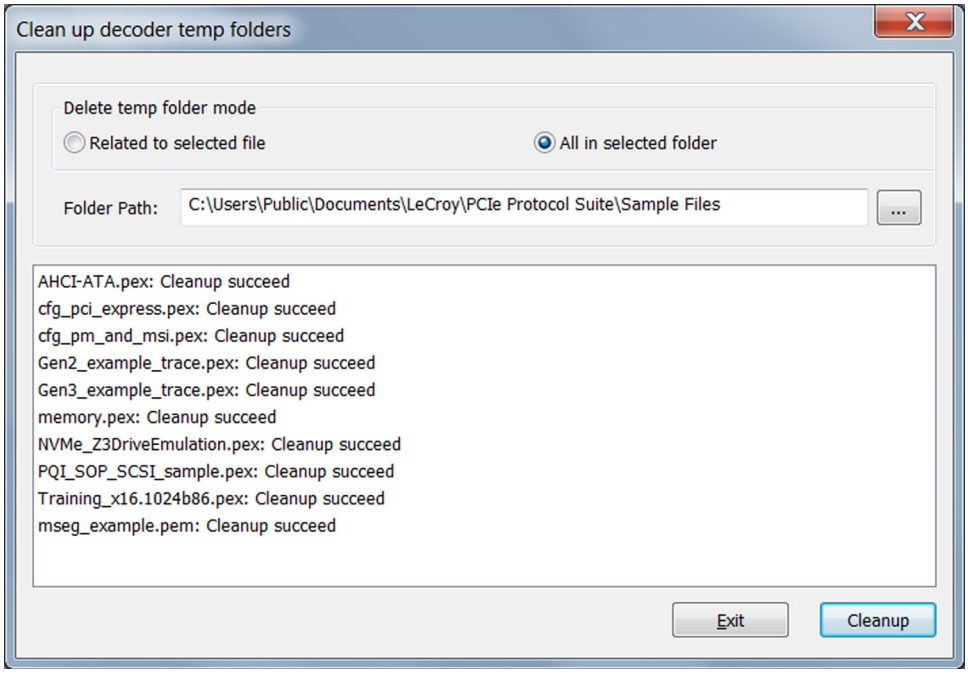


Figure 4.9: Results of Running Clean Up Command

11. Confirm that the Clean Up Command was successful by viewing the C:\Users\Public\Documents\LeCroy\PCIe Protocol Site\Sample Files folder contents, (see Figure 4.10).

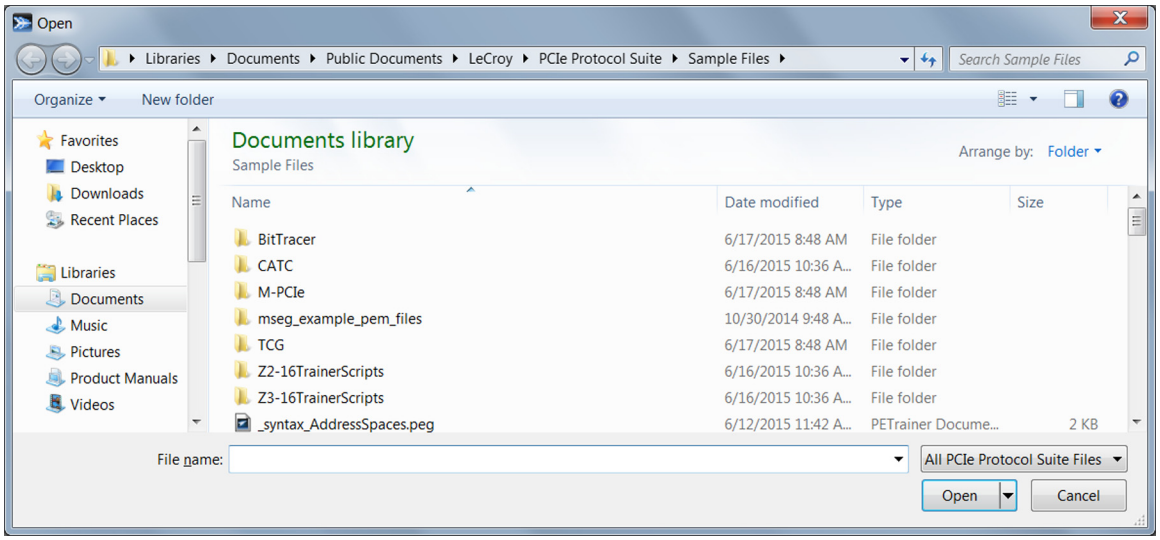


Figure 4.10: Sample File Folder After Temp File Clean Up

12. Compare Figure 4.5 on page 169 with Figure 4.10 to ensure that the .tmp files have been deleted.

4.5.2 Setup Menu

Display Options	Allows you to customize display options such as field colors, field formats and level hiding.
Recording Options	Allows you to customize control and setup features associated with recording, triggering, and filtering recorded events.
Generation Options	The Generation Options dialog is used to set configuration settings in a traffic generation script (*.peg). This dialog provides a convenient alternative means of editing a traffic generation file.
Generation Macros	Opens a dialog for creating buttons on the status bar that can be used to run traffic generation macros.
Update Device	Opens a dialog box that lets you update the BusEngine™ and Firmware.
Launch CrossSync Control Panel	Launches the CrossSync application. The CrossSync Control Panel allows you to select analyzers for synchronization and manage the recording process. See “CrossSync Control Panel” on page 214.
All Connected Devices	Opens a dialog box with a list of locally or remotely connected devices. Allows you to update the BusEngine, Firmware, and your licensing information.

4.5.3 Record Menu

Start	Causes the Analyzer to begin recording traffic.
Stop	Causes the Analyzer to stop recording traffic.
Reupload	Causes the Analyzer to re-send all, or selected portions, of the CATC Trace from the Analyzer buffer to the host machine.
Manual Trigger	Trigger command for Analyzer is generated upon clicking this button.

4.5.4 Generate Menu (used in conjunction with Teledyne LeCroy Trainer products)

Connect	Connects the Analyzer
Disconnect	Disconnects the Analyzer.
Switch to 2.5 GT/s	Switches to 2.5 GT/s speed.
Switch to 5.0 GT/s	Switches to 5.0 GT/s speed.
Switch to 8.0 GT/s	Switches to 8.0 GT/s speed.
Write Address Space	Writes to the Address Space.
Read Address Space	Read from the Address Space.

4.5.5 Report Menu

Report Menu operations are only available when you are working with a CATC Trace file.

Trace Expert Report	Generates Reports for the currently loaded trace: Performance Analysis, Trace Analysis, Errors, File Information.
Trace Information	Displays information about the file contents and describes the conditions of the file's recording (Recording Options, hardware information, and so on).
Error Summary	Displays an error summary of the current CATC Trace file and allows you to go to a specific packet, and save the error file to a uniquely named file.
Traffic Summary	Details the number and types of packets that were transferred during the recording. You can hide, save, send, text, print, and view.
Bus Utilization	Opens a window with graphs of bus usage for the open CATC Trace.
Link Tracker	Opens a window for displaying a detailed chronological view of traffic. The window provides view and navigation options.
Data Flow	Opens the Data Flow Window, providing a tabular view of transactions and their payload.
Trace Navigator	Shows the Navigator bar for navigating a CATC Trace. Shows a snapshot of the recording and allows you to adjust the memory area for the view.
LTSSM Flow Graph	Shows a state diagram of bus activity. Also allows you to navigate through the LTSSM, based on the current recording.

Packet Header	Opens the Packet Header bar, showing the Packet Header information as it would be viewed in the specification.
Packet Data	Opens the Data Window for the current packet or transaction, with the options: Hide, Save, Hexadecimal, ASCII, Decimal, Binary, MSB Format, LSB Format, Big Endian, and Little Endian. Format Line allows you to enter the number of bytes, words, or dwords per line.
Configuration Space	Presents a list of Configuration Spaces. Clicking an item displays the selected Configuration Space in a Configuration Table format.

4.5.6 Search Menu

Search Menu operations are only available when you are working with a CATC Trace file.

Go to Trigger	Repositions the display to show the first packet following the trigger event.
Go to Selected Packet	Repositions the display to a specific packet, Link or Split transaction of PCI Express protocol or NVME, PQI, AHCI, ATA, SOP and SCSI command transaction levels.
Go to Segment/ Packet	Allows searching for specific link events packets or time.
Go to Time	Repositions the display to specific timestamp.
Go to Marker	Repositions the display to a previously marked packet, Link, Split, NVME, PQI, AHCI, ATA, SOP or SCSI command transactions.
Go to NVMe Transaction	Allows searching for Controller Registers, Other NVMe Entities, Doorbell Registers, Admin Submission Command Set, NVM Submission Command Set, Completion Queue Entry and NVMe Errors.
Go to NVMe Command	Allows searching for Admin Command Set NVM Command Set, Status, Errors, TCG Types, TCG Method, TCG Invoker, TCG Com ID and TCG Ext Com ID.
Go to SCSI	Allows searching for SCSI commands and sub-commands: SCSI Operation, Command Status, Task Management, Task Management Response, Error, SCSI Logical Unit Number.
Go to	Allows searching for specific link events: TLP Type, DLLP Type, Ordered Set, Link Event, Traffic Class, DLLP Virtual Channel, TLP Virtual Channel, Direction, Speed, Link Width, Requester ID, Completer ID, Data Lengths, Errors.

Find	Displays the Find dialog to allow searching for various events within a CATC Trace. You can search by Display Level: Packets, Link or Split transaction of PCI Express protocol or NVME, PQI, AHCI, SATA, SOP and SCSI protocol Transaction. You can search packets by Event Group: TLP Type, TLP Header, TLP Requester ID, TLP Completer ID, TLP Data Pattern, TLP Data Lengths, TLP Tag, TLP Sequence Number, DLLP Type, DLLP Header, DLLP Virtual Channel, ACK/NAK Seq Number, Ordered Sets, Link Event, Direction, Errors, TS1 Data, TS2 Data. You can search link transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag. You can search Link, Split, NVMe and PQI transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag, Address. You can search for LN transactions: Notification Reason, Cacheline Size, Cachelines, Completion Status, Read/Write, Directed/Broadcast and Errors. You can search NVMe transactions by the following Event Groups: Controller Registers, Queue IDs, Command IDs, Doorbell Registers, Admin Submission Command Set, NVMe Submission Command Set, Completion Queue Entry, and PRP. You can search PQI transactions by Event Group: PQI Register ID, PQI Admin Functions, PQI Errors. You can search AHCI transactions by Event Group: AHCI Register ID, AHCI Port Number, AHCI Slot Number, AHCI Port Multiplier Port, Raw Address, AHCI Direction, AHCI Errors. You can search ATA transactions by Event Group: ATA Register Type, ATA Port Number, ATA Slot Number, ATA Raw Address, ATA Port Multiplier, ATA Interruption Reason, ATA Error Type, ATA Input/ Output, ATA Payload Portion, ATA CFS Fields, ATA RFIS Device to Host Fields, ATA DSFIS Fields, ATA PSFIS Fields, ATA SDBFIS Fields. You can search SOP transactions by Event Group: SOP Information Unit ID, SOP Errors. You can search SCSI transactions by Event Group: SCSI Operation, Command Status, Task Management, Task Management Response, Errors, SCSI Logical Unit Numbers.

	You can search NVMe Commands: Admin Command Set, NVM Command Set, Submission QID, Completion QID, Status, Errors, LBA, NVM Command, NVM Payload Portion, TCG Types, TCG Method, TCG Invoker, TCG Com ID, TCG Ext Com ID and RPMB. You can search for the MCTP transactions: MCTP Packets, MCTP Source Endpoint ID, MCTP Destination Endpoint ID or MCTP Control Messages.You can search for the MCTP transactions: MCTP Packets, MCTP Source Endpoint ID, MCTP Destination Endpoint ID or MCTP Control Messages. Find allows you to create complex searches based on numerous criteria.
Find Next	Repeats the previous Find or Search operation.
Toggle Search Direction	Changes the current search direction from Forward to Backward or from Backward to Forward. Current search direction shown in lower right hand corner of main PCIe Protocol Analysis Menu.

4.5.7 Quick Search Feature

The Quick Search feature allows you to either search for a pre-defined term (see Figure 4.11) within a loaded Trace by clicking on the down arrow or by typing your own term into the search window and then moving the cursor into the window and hitting the Enter key. The terms available are dependent on the trace which has been loaded.

For a list of all possible terms, refer to "Quick Search Feature" on page 727.

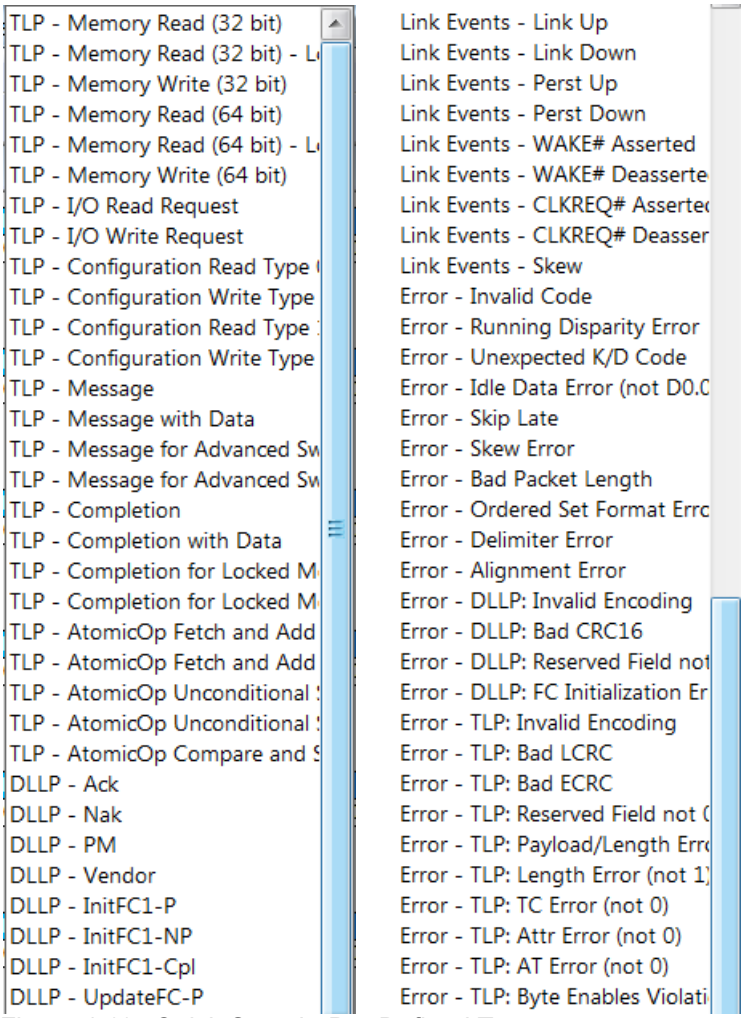


Figure 4.11: Quick Search: Pre-Defined Terms

This feature will scroll through the entire Trace searching for the requested term and either stop at a highlighted Packet within the Trace or not move to a new position in the Trace if the term was not found. For any example of searching for a term in a trace, see "Example: Quick Search Feature" on page 569.

4.5.8 View Menu

Toolbars>>	Displays available toolbars: Standard, View Type, Frequently Used, Analysis, and Transaction Level. Use Customize to display the Windows Customize window.
Analyzer Network Chat Bar	Opens a chat window for communicating with persons working with networked Analyzers. This command requires that your host machine be attached to a LAN. The Chat window broadcasts messages to whatever host machines have been connected.
Status Bar	Switches display of the Status Bar on or off.
QuickTiming Bar	Switches display of the QuickTiming Bar on or off.
CATC Walk	Lets you play a playlist or manage Playlists (see “CATC Walk Playlist” on page 536).
Real Time Statistics	Opens the Real Time Statistics monitor dialog and displays a real-time graph of link activity.
Unhide Cells	Unhides PQI Reserved, PQI SGL Reserved and SOP reserved cells. You can also select Unhide all.
Script Editor	Displays the Script Editor (only appears if a **.peg** file is open).
Zoom In	Zoom in increases the size of the displayed elements.
Zoom Out	Zoom out decreases the size of the displayed elements.
Wrap	Wraps displayed packets within the window.
Synchronize Trace View With Other Views	Synchronizes the Trace view with other views.
FC Credits	Toggles a display for tracking Flow Control Credit update and consumption on a PCI Express link.
FC Credits Setup	Allows you to customize the display for tracking Flow Control Credits.
Compact View	Toggles compacting of the Link Training sequence to analyze CATC Trace data faster or no compacting to display more data.
Packet Level	View the current recording at the Packet Level.
Link Transaction Level	View the current recording at the Link Transaction Level.

Split Transaction Level	View the current recording at the Split Transaction Level.
Lightweight Notification Commands and Responses	View the current recording of Lightweight Notification Commands and Responses.
NVMe Transaction Level	View the current recording at the NVMe Transaction Level.
PQI Transaction Level	View the current recording at the PQI Transaction Level.
ACHI Transaction Level	View the current recording at the ACHI Transaction Level.
ATA Transaction Level	View the current recording at the ATA Transaction Level.
SOP Transaction Level	View the current recording at the SOP Transaction Level.
SCSI Transaction Level	View the current recording at the SCSI Transaction Level.
Restore views to default positions	Restores views to the default positions after you click **Yes** on the prompt.

4.5.9 Tools Menu

Configuration Space Editor	Displays the Configuration Space Editor dialog which allows you to either create a new Configuration Space File or open an existing Configuration Space File.
Memory/IO Space Editor	Displays the Memory/IO Space Editor dialog which allows you to either create a new Address Space File or open an existing Address Space File. Select the memory size from the drop-down menu.

TC to VC Mapping	Allows Traffic Classes to be mapped to Virtual Channels for purposes of simplifying navigation (for example, Search > Go to > TLP Virtual Channel) and changing the way the CATC Trace is displayed (for example, in Split Transactions).
Timing Calculations	Starts the mode-less calculator dialog for calculating various timing and bandwidth parameters in the recording file.
PCIe SSD Base Address Mapping	Displays the PCIe SSD Base Address Mapping dialog.
Run Verification Scripts	Displays a list of verification scripts, from which you can run a verification script.

4.5.10 Window Menu (helps display the loaded traces)

New Window	Opens a copy of the current CATC Trace window.
Cascade	Displays all open CATC Trace windows in an overlapping arrangement.
Tile	Displays all open CATC Trace windows as a series of strips across the display.
Arrange Icons	Arranges minimized CATC Trace windows at the bottom of the display.
Synchronize Traces	Synchronizes a BitTracer trace and a Protocol trace exported from it such that their views scroll together based on timestamps.
Windows	Displays all open windows. Select to display. See Figure 4.12 on page 182 and Figure 4.13 on page 182 as well as “Trace Display Options” on page 183.

For a more detailed explanation of the Window Menu options see Figure 4.12 and Figure 4.13 as well as “Trace Display Options” on page 183.

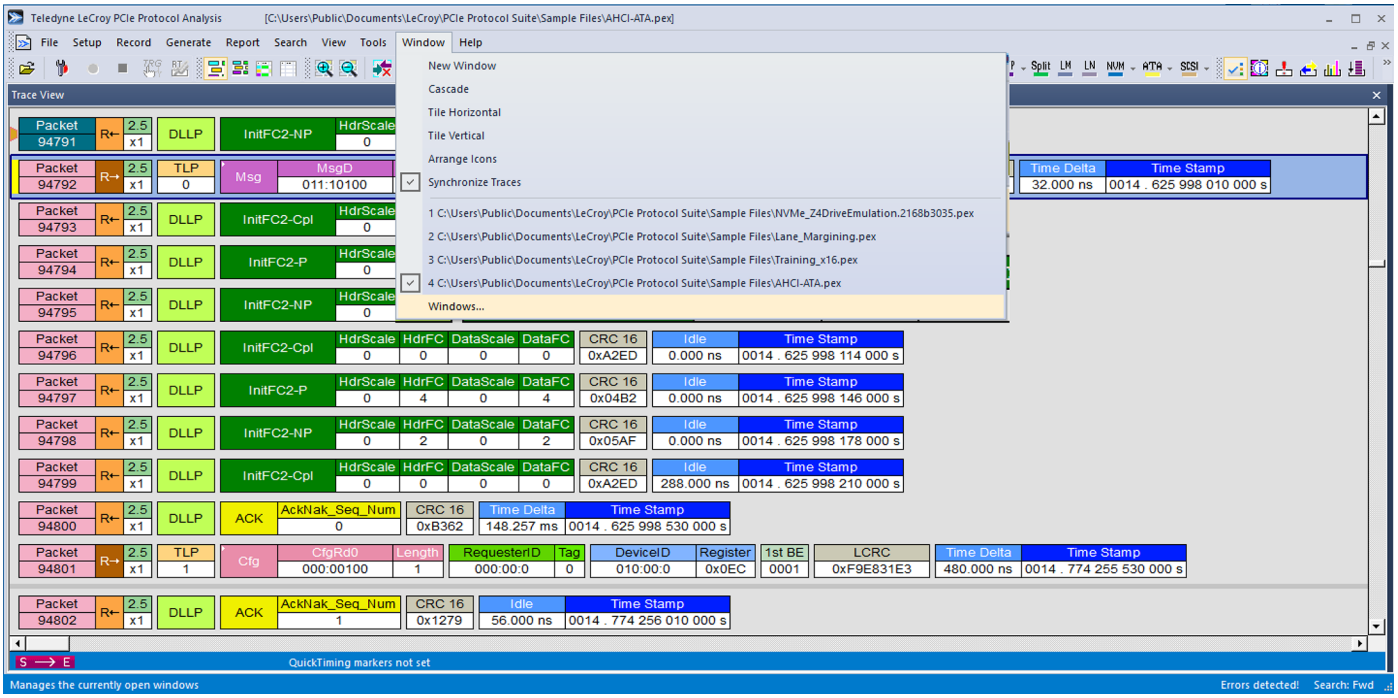


Figure 4.12: Window: Windows Menu with four traces loaded

If you select Windows from the options above a new menu will popup with the list of loaded traces. See Figure 4.13.

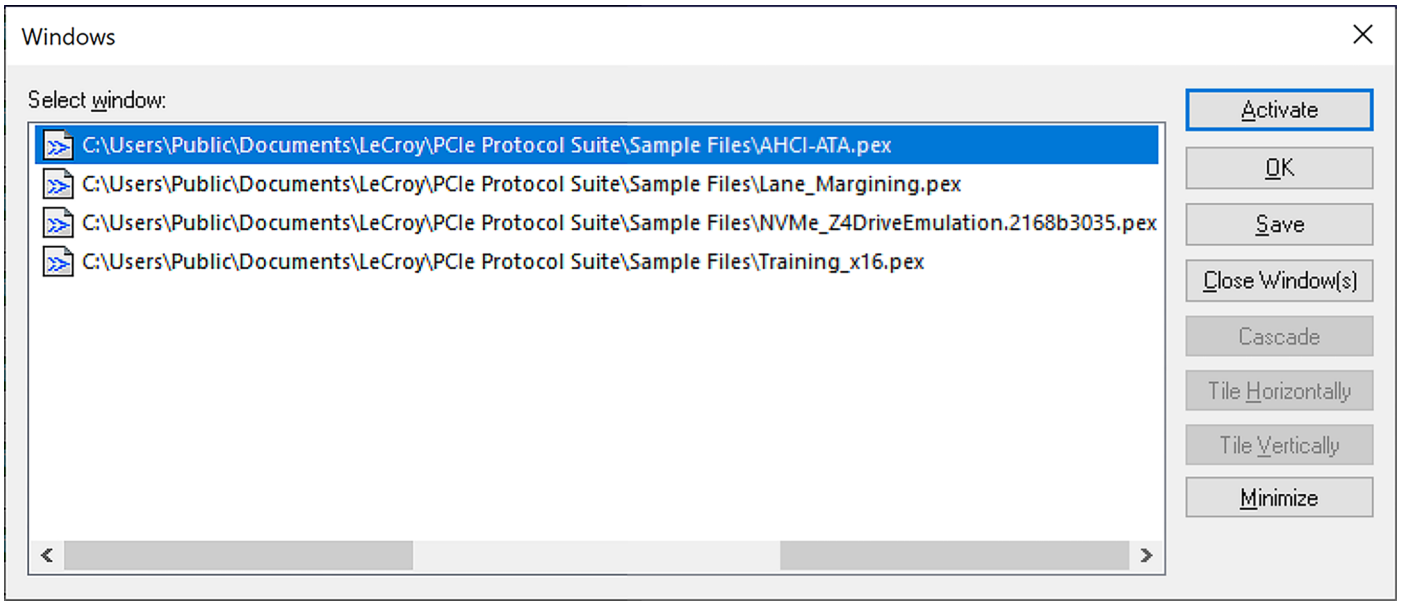


Figure 4.13: Window: Windows menu with four traces loaded

Trace Display Options

You have the following options on how the traces are displayed:

- Activate - makes selected trace active in a Trace View.
- OK - closes dialog.
- Save - This is useful for Generation Scripts, it brings up save dialog to save changes in generation script, for opened trace it does nothing.
- Close - closes selected window(s).
- Cascade, Tile Horizontally and Tile Vertically - enabled only when multiple windows are selected. Cascades or tiles selected windows.
- Minimize - minimizes selected window.

4.5.11 Help Menu

User Manuals F1	Click User Manuals or press F1 to access the documentation guide for all Teledyne LeCroy PCIe products.
Display License Information	Opens an information box describing the current license information.
Register Product Online	Register at the Teledyne LeCroy website registration page.
Check for Updates	Check whether a new software version is available. If so, you can download from the Teledyne LeCroy web site. You can select to **Check for updates at application startup**
Tell Teledyne LeCroy	Report a problem to Teledyne LeCroy Support via e-mail. This requires that an e-mail client be installed and configured on the computer.
Shortcut List	Displays a list of Keyboard shortcuts.
About PCIe Protocol Analysis	Displays version information about the attached Analyzer and its Firmware and BusEngine™.

4.6 Dashboard View

Dashboard View shows the state of the link that the analyzer is tracking. To view the Dashboard for the selected device, click the  Dashboard View icon at the bottom left of the application. The image below shows the dashboard for a Summit T3-16 Analyzer, however, all Summit Analyzers have similar Dashboards showing corresponding supported parameters.



Figure 4.14: Dashboard View Icon Displaying Device

4.6.1 Dashboard Information

Dashboard (see Figure 4.15 on page 185) displays the following information for Upstream and Downstream:

- Link Width
- Link speed
- Per lane activity indication
  - Green - lane is active, analyzer does not detect any signal errors on this lane
  - Orange - lane is active, analyzer detects signal errors on this lane
  - Grey - lane is inactive

- Logical to physical lane mapping
- Lane polarity
- Link Number
- NFTS - The number of FTS advertised by the device for each speed

Note: The dashboard display depends on the Recording Options configuration and may not match the current actual link state. For example, if the analyzer is configured to track 2.5 GT/s speed only, the Dashboard View will display 2.5GT/s speed as a current tracking speed regardless of the actual speed of the link.

Note: The update to the status bar requires reading the current state of the analyzer. This happens at the end of the recording. In case the analyzer is power cycled, perform at-least one recording to have the updated status bar with current analyzer link information.

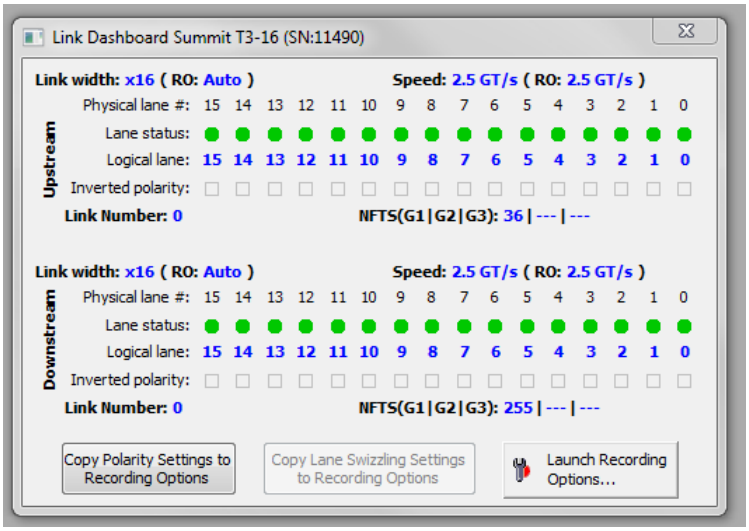


Figure 4.15: Dashboard View Dialog

You can launch Recording Options for the analyzer from the Dashboard View and adjust recording settings to match the current link configuration. The **Copy Polarity Settings to Recording Options** button allows you to copy the detected polarity into Recording Options. The **Copy Lane Swizzling Settings to Recording Options** button allows you to copy the detected Lane Swizzling Settings into Recording Options.

Note: Polarity auto detection and lane swizzling detection requires the link to go through link retraining at Gen1 or Gen2 speed. The analyzer has to be configured correctly to track this link retraining. For example, if the analyzer is configured to track only 8.0 GT/s speed, auto polarity detection will not work even if the link goes through the appropriate retrain.

4.6.2 Launching and Setting Recording Option from Dashboard View

You can select a device and click the **Launch Recording Options as shown in** Figure 4.15 button to go to **Recording Options**. In the Recording Options window the Upstream and Downstream channels can be set manually by unchecking the **Auto-Configure Lane Polarity** checkbox, refer to

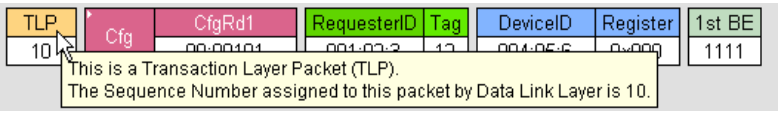
Figure 5.1 on page 217 (3G). Click on the **Port Polarity Settings to Recording Options** to save the settings.

Note: The lane polarity values are dynamic so this feature allows the user to make the settings and save them for future use.

In the default setting the **Auto-Configure Lane Polarity** checkbox is selected, refer to Figure 5.1 on page 217 (3G).

4.7 Tool Tips

Tool tips provide details about fields within the CATC Trace. To see a tool tip, position your mouse pointer over a field within the CATC Trace.



You can turn off this capability in the Display Options menu.

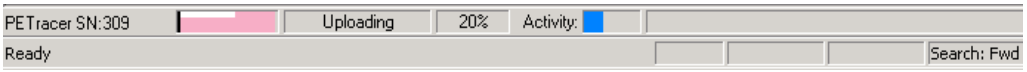
4.8 Keyboard Shortcuts

Keystrokes	Operation
Ctrl + N	New PCIe Protocol Analysis script
Ctrl+O	Open file
Ctrl+P	Print
Ctrl+S	Save file
Ctrl + R	Start Analyzer recording
Ctrl + T	Stop Analyzer recording
Ctrl+Home	Jump to first packet
Ctrl+End	Jump to last packet
Ctrl + G	Go to packet...
Ctrl + F	Search forward
Ctrl + 1	Access documentation

F3	Find next
F6	Next pane
Shift+F6	Previous pane
Ctrl+B	Search backward

4.9 Status Bar

The Status Bar is a gray bar that runs along the bottom of the application window.



From left to right:

PCIe Protocol Analysis SN:309: Analyzer Serial Number

Ready: Analyzer Status

Recording Progress Bar: The colored bar to the right of the serial number represents how much traffic has been recorded. The trigger point is indicated by the black line at the left side of the bar. In this example, the trigger occurred at the very beginning of the CATC Trace. If the trigger is set in the middle of the CATC Trace, the line is positioned in the middle of the bar. Additionally, the color of the bar is different on each side of the trigger point. For examples, see “Recording Progress Bar” on page 187. The white strip along the top edge of the color bar indicates how much traffic has been uploaded from the Analyzer buffer to the host machine.

Uploading and 20%: Indicates the Analyzer's recording status, what part of the recording process the Analyzer is now in. In this example, the Analyzer is in the upload stage and has completed 20% of the upload from the Analyzer to the host machine. See “Recording Status” on page 187 for details on other status messages.

Activity: The colored bar moves to indicate that the Analyzer is currently recording.

Search: Fwd: Indicates search direction. The direction can be toggled to **Search: Bwd** by double-clicking the search direction or by selecting **Search Direction** from the Search menu.

4.9.1 Recording Progress Bar

This indicator bar changes color to reflect the recording progress.

- Black vertical line is at the location of Trigger position.
- Black vertical line wiggles when Trigger Position is nearly reached.
- Field to right of Trigger Position changes color to indicate post-trigger activity.
- Upper half of progress indicator turns white when recording is complete.

4.9.2 Recording Status

The second segment from the left in the Status Bar indicates recording status.

During recording, the current Recording Status is in a segment. When you activate the **Record** function, this segment flashes a message depending on the selected Recording Options, such as **Waiting for Trigger**, **Uploading** or **Triggered**.

- The status bar displays **Waiting for Trigger** while waiting for trigger to occur based on the settings defined in the Recording Options.



Figure 4.16: Status Bar - Waiting For Trigger

The status bar displays **Uploading** when recording is complete and is being uploaded (see Figure 4.17 on page 188).

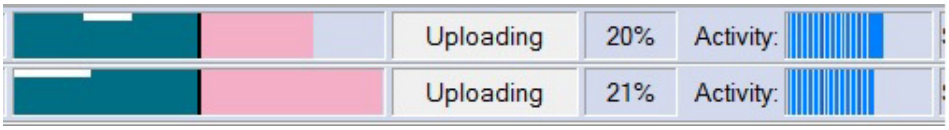


Figure 4.17: Status Bar - Uploading

The status bar displays **Triggered** when the trigger condition has occurred, but uploading has not commenced yet.

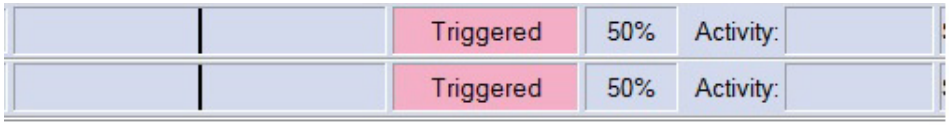


Figure 4.18: Status Bar - Triggered

As uploading progresses, the percent increases to 100. You can abort this upload if you wish by pressing the **ESC** button on your keyboard or

clicking  in the Tool Bar.

4.9.3 Recording Activity

The third segment displays recorded activity as a series of blue vertical bars. The more vertical bars that display, the greater the amount of activity recording. If there are no vertical bars, there is no recording activity.

During uploading, the percent of the completed upload displays.

4.9.4 Search Direction Indicator

The fourth segment in the status bar indicates search direction. The direction can be changed by selecting Search Direction from the Search menu.

4.10 Making a PCI Express Recording

After connecting the Analyzer to the device(s), you must configure the Recording Options. Then you can test the Analyzer by creating a 16-MB snapshot recording.

To make this recording, follow these steps:

1. From the **Setup** menu, select **Recording Options** and click the **Switch to Simple Mode** button.
2. Select the **Simple Mode** tab (see Figure 4.19 on page 190). The image shown is for Summit T3-16 Analyzer but all Summit Analyzers have similar dialogs. The Summit T3-8 has a different Link Width (see Figure 4.20 on page 191). The Summit T34 has a different Link Width, an NVMe Recording mode (see "NVMe Enhanced Recording Mode: Summit T34 Only" on page 369) and a slightly different set of Reference Clock selections (see Figure 4.21 on page 192). The Summit T28 has a different Link Width and set of Reference Clock selections (see Figure 4.22 on page 193). The Summit T24 has a different Link Width and set of Reference Clock selections (Figure 4.23 on page 194). The different options are described in more detail in Chapter 5 (see "Recording Options" on page 215).

   The following window displays the factory default settings in **Simple Mode**, such as Snapshot and 32-MB buffer size. For your first recording, select the proper speed and link width.

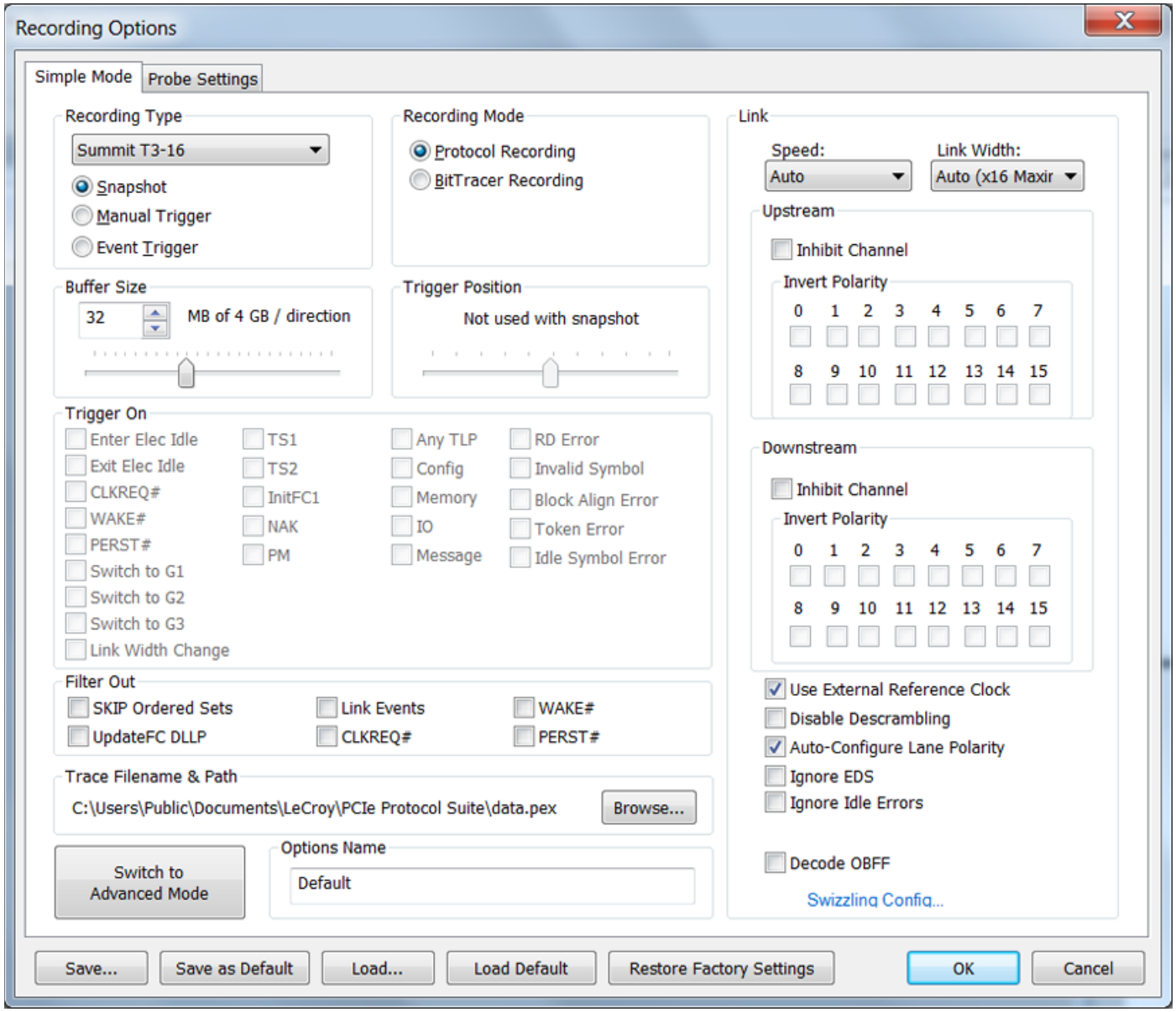


Figure 4.19: Summit T3-16 in Simple Recording Mode

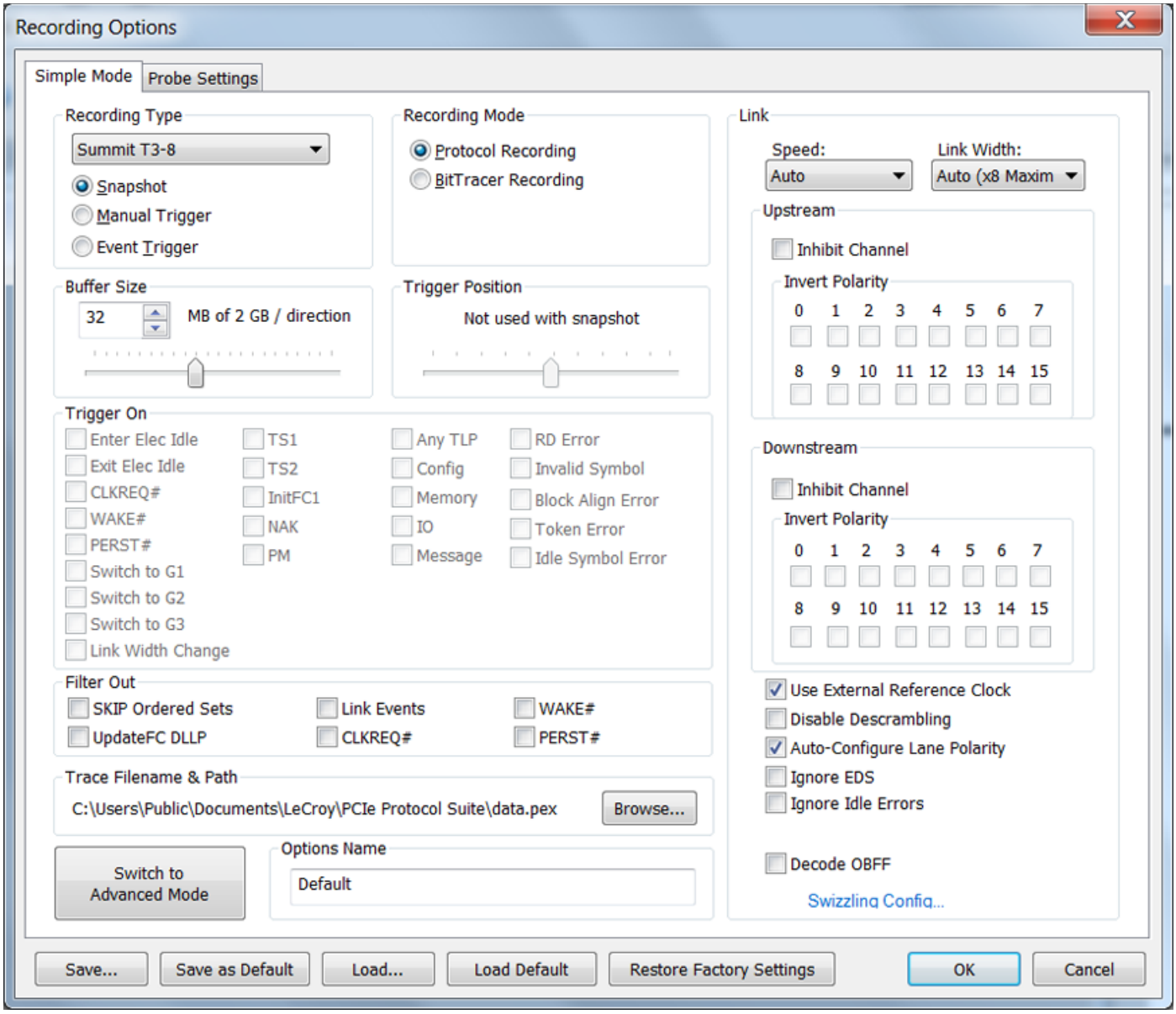


Figure 4.20: Summit T3-8 in Simple Recording Mode

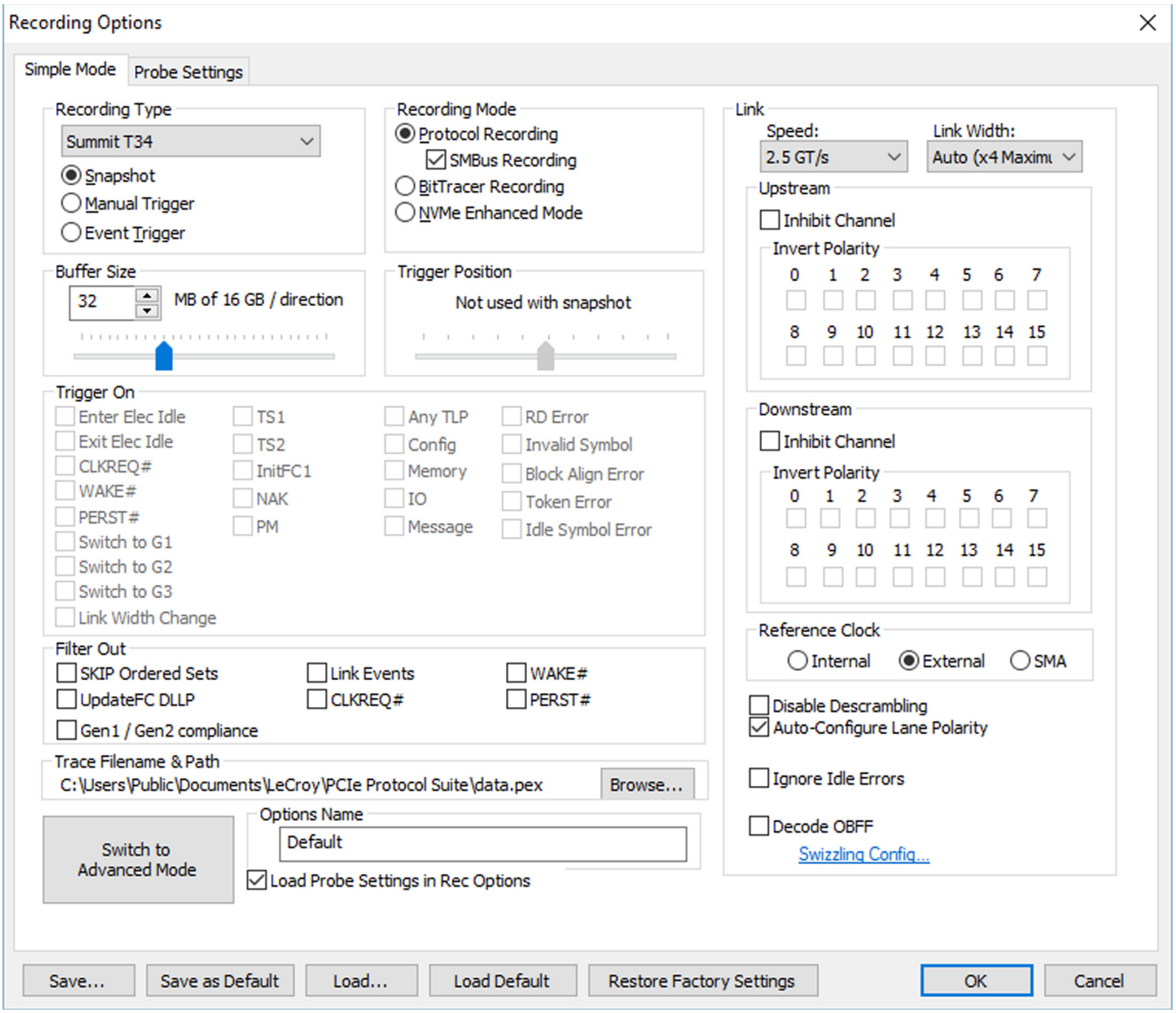


Figure 4.21: Summit T34 in Simple Recording Mode

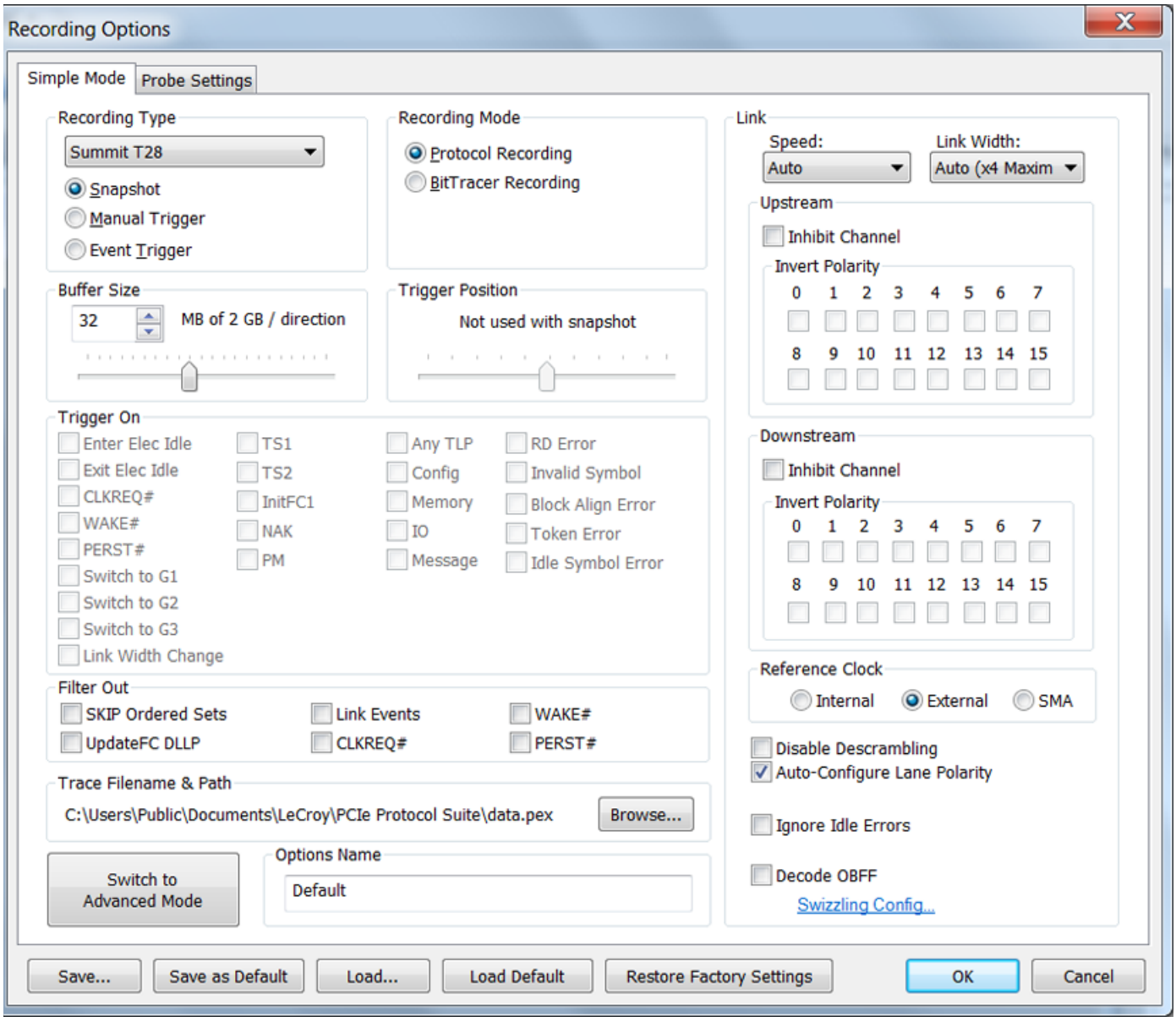


Figure 4.22: Summit T28 in Simple Recording Mode

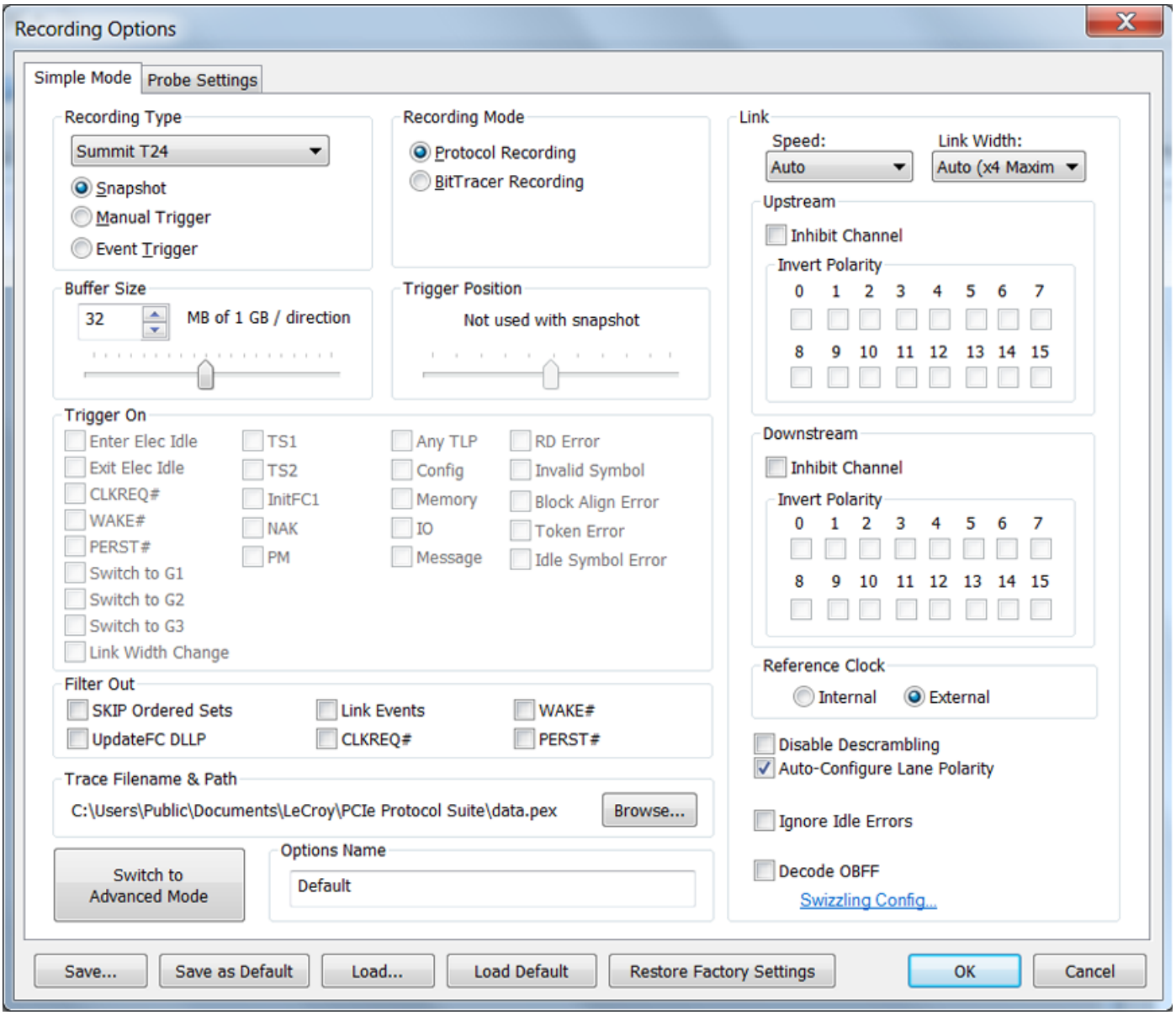


Figure 4.23: Summit T24 in Simple Recording Mode

3. In the **Link** section, specify the link width of the PCI Express link to be analyzed. The rest of the settings in this section can be left at the factory defaults for most PCI Express systems.
4. For multi-lane PCI Express links when using Auto options, the Analyzer needs to observe link training in order to record link traffic correctly.
5. Click **OK** at the bottom of the Recording Options dialog to apply the Analyzer recording settings specified.
6. Click the **Record** button.

4.10.1 Stopping a Recording

You can stop the recording process at any time by pressing the **Stop** button ■ . This causes the Analyzer to stop the recording and upload the CATC Trace to the host machine. If you press the **Stop** button again, the Analyzer temporarily halts the upload process and opens the following dialog box.

Note: If the uploading process is stopped manually, the resulting trace may have significant periods of time where the traffic from upstream and downstream will seem like they are not interleaved. Teledyne recommends to always let the analyzer complete the upload process.

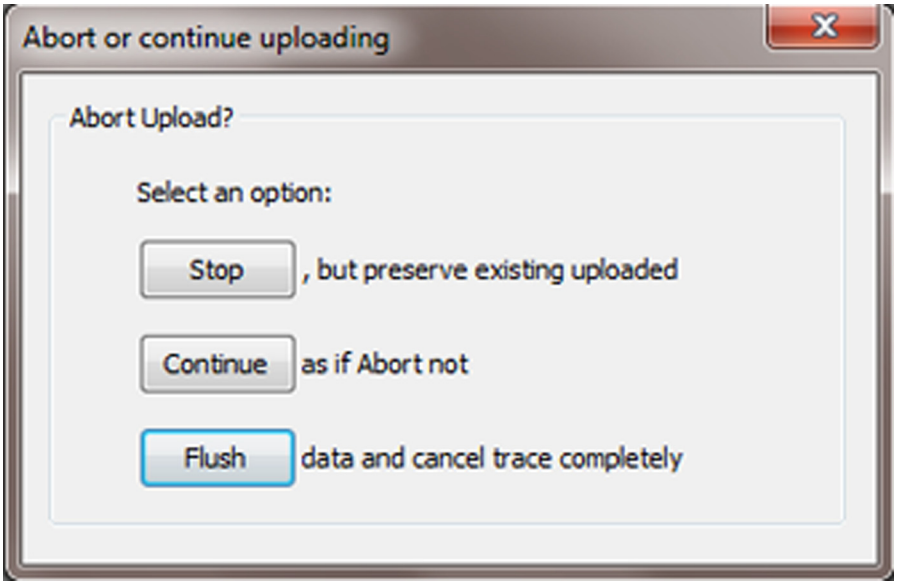


Figure 4.24: Abort Upload

This dialog presents options for stopping, continuing, or aborting the upload:

- **Stop**: Aborts further CATC Trace upload and displays whatever data that has already been uploaded.
- **Continue**: Resumes the upload. This command tells the Analyzer to finish uploading whatever CATC Trace data is still in its buffer.
- **Flush**: Flushes the CATC Trace without saving or displaying it.

If you allow the traffic data to be uploaded, it is automatically saved on the host machine's hard drive as a file named **data.pex** or the name you assign as the default filename in the recording options.

4.10.2 Saving a Recording

1. To save a current recording for future reference, select **Save As** from the File menu.
2. Give the recording a unique name, then save it to the appropriate directory.

4.11 PCIe Protocol Analysis Files

The PCIe Protocol Analysis creates and uses different kinds of files:

- **CATC Trace Files**: Recorded traffic
- **Recording Options Files**: Configuration file that contains the various options selected in the Recording Options dialog to configure the recording
- **Display Options Files**: Configuration file that contains the options selected in the Display Options dialog to configure how traffic is displayed

4.11.1 CATC Trace Files

PCIe Protocol Analysis records PCI Express traffic into a CATC Trace file with the default name **data.pex** or any other that you specified in the Recording Options. This file is overwritten with new data each time PCI Express traffic is recorded.

If you want to save a CATC Trace, use the **File > Save As** function. This option allows you to save the current CATC Trace to a unique file name, thereby ensuring that it is not overwritten. This option also allows you to save a range of packets in a CATC Trace file.

You can pre-define the name of the recorded CATC Trace file using the Trace Filename and Path option in Recording Options.

4.11.2 Recording Options Files

Recording Options files are created when you set recording options. These files use the **.rec** extension and contain recording option information.

4.11.3 Display Options Files

Display Options files are created when you set display options. These files use the **.opt** extension and contain the display options information.

4.12 Saving CATC Trace Files

4.12.1 Using the Save As Function

When you record a CATC Trace file, the Analyzer software provides a pre-defined name to the CATC Trace file (**data.pex** or any other that you specified in the Recording Options). If you do consecutive recordings, each time the previous recording is overwritten. If you see a recording you want to analyze later, you need to give a unique name to the CATC Trace file, so it is not overwritten with the next recording.

Also, when you analyze a recorded CATC Trace file, you might be interested in preserving just a part of the PCI Express traffic that was recorded. If you save a portion of a CATC Trace file, it can get significantly smaller, allowing you to attach it to an e-mail.

To save a portion of a CATC Trace file or the whole file to a unique name, select **Save As** from the File menu (see Figure 4.25 on page 197).

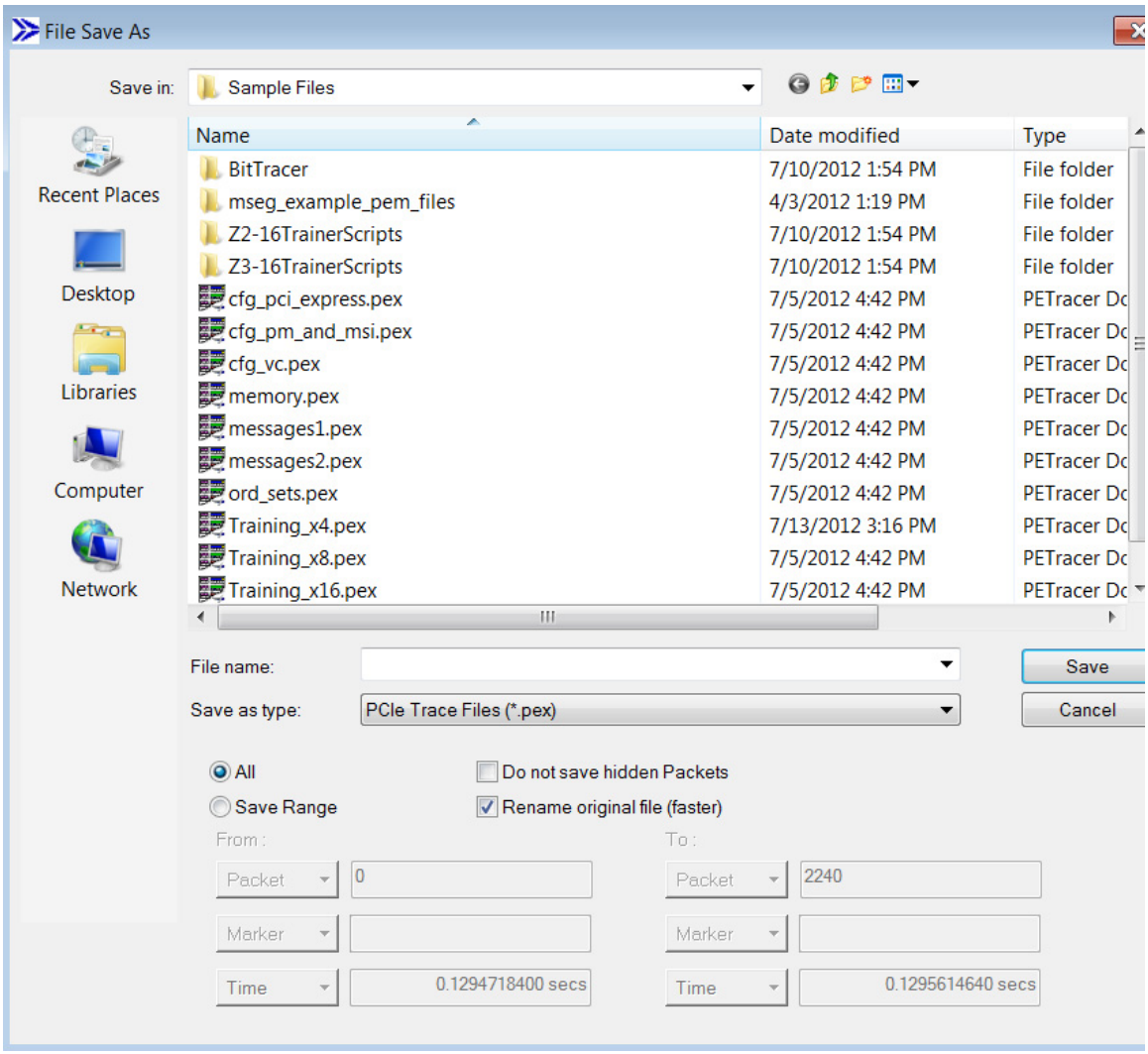


Figure 4.25: File Save As Dialog

If you want to give a unique name to the CATC Trace file, select the **All** option and keep **Rename original file** checked. This is the default setting for the dialog. The existing file will be overwritten with the new file name.

4.12.2 Saving a Portion of a CATC Trace

If you want to save a portion of a CATC Trace file, select **Save packet range**. Enter starting and ending packet numbers in the **From Packet** and **To Packet** fields. By default, it has the numbers of the first and the last packets in the file. The software is going to save all the packets in specified range to the new file, unless you have **Do not save hidden packets** checked. In this case it is going to save all packets in the range, EXCLUDING the currently hidden packets.

4.12.3 Save Copy As Function

If you want to Save a trace (or a portion of a trace) to a new file name but keep the existing file name select Save Copy As. See Figure 4.26.

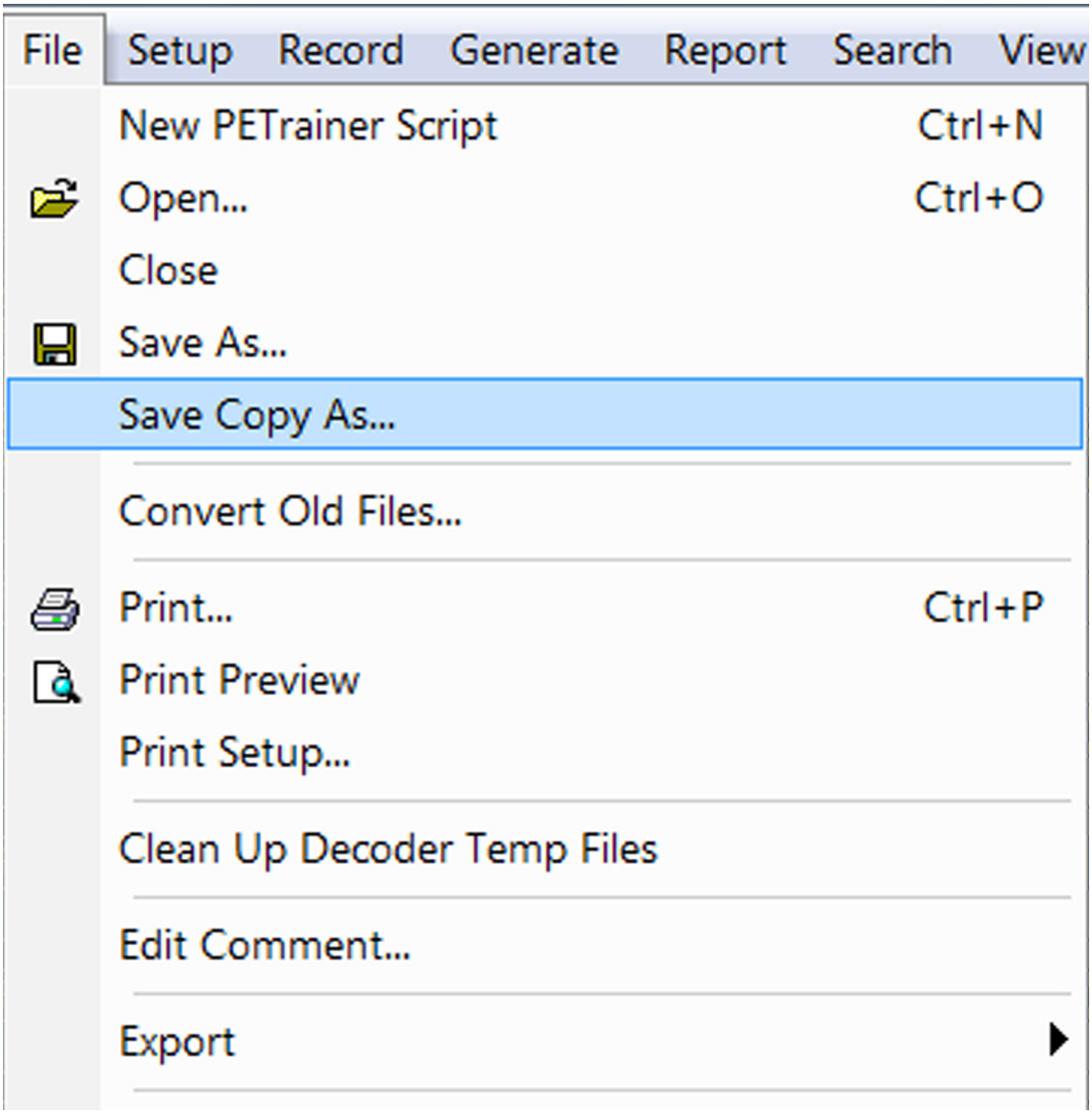


Figure 4.26: File -> Save Copy As Function

Select Save Copy As and the following dialog will pop up and you can enter a unique file name (see Figure 4.27 on page 199).

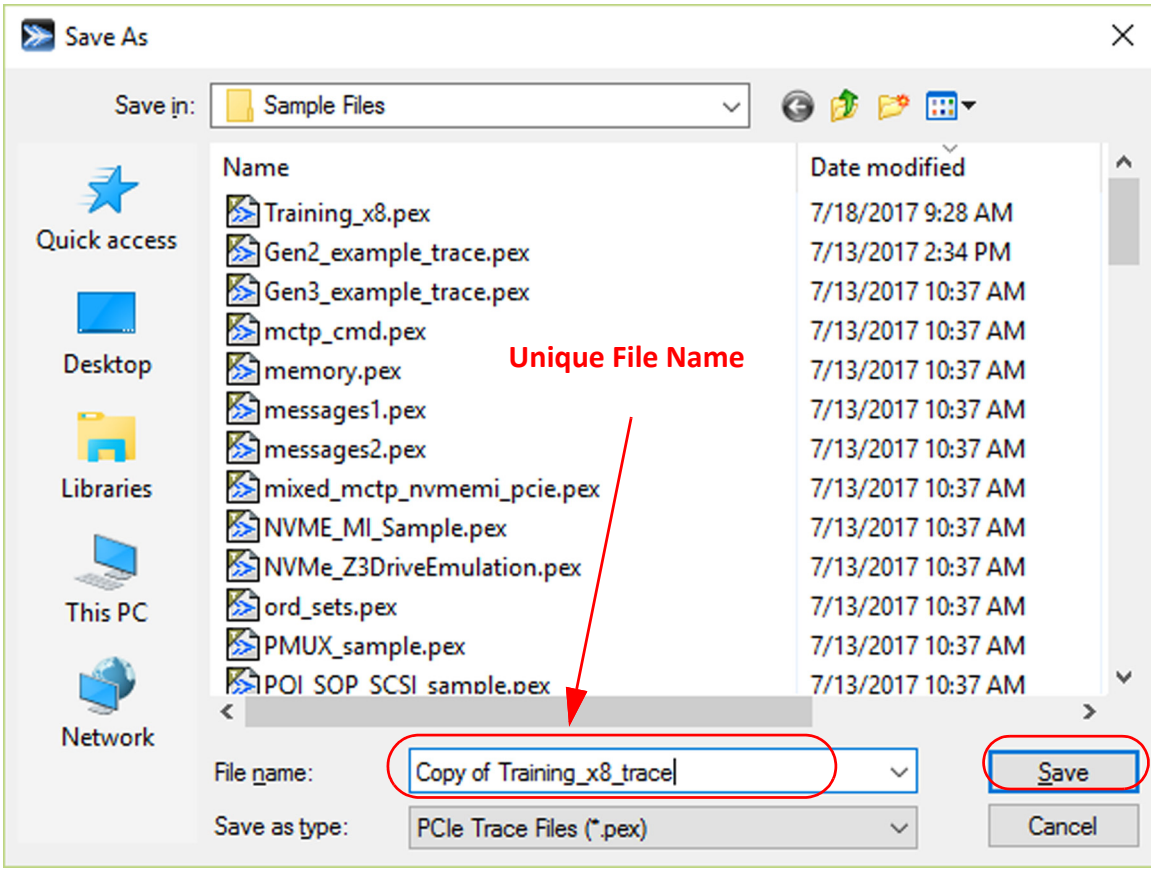


Figure 4.27: Save As Copy Dialog (Sample File Directory Before Save)

Click on the Save button and the trace will be saved with the new file name. This file can be loaded by Selecting File -> Open and selecting the new file and selecting the Open button. See Figure 4.28 on page 200.

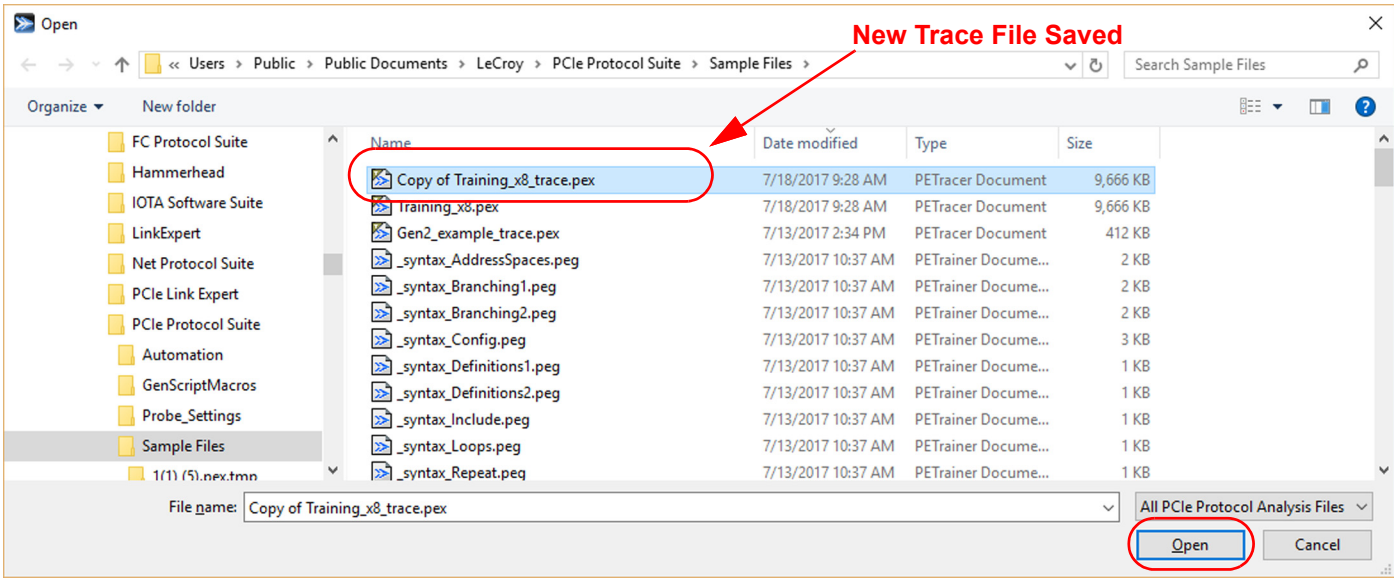


Figure 4.28: File -> Open: New Trace File Available

4.12.4 Trace File Structure

The captured trace file has an extension of ".pex". When the trace file is loaded, additional decoding and data reduction is done which results in additional files of data which are placed in a folder of the same name as the trace file (with the extension ".tmp"). This allows the trace file to be loaded and displayed quickly during subsequent viewings.

When copying a trace file, or sending it to someone, you can chose to send just the .pex file. In that case, the software re-generates the additional folder and files when the trace is first opened. The other choice is to send the additional folder with contents along with the .pex file, which will save the rebuilding effort when the file is opened again. The choice is up to the user. If you do NOT want these files kept, and don't mind the extra time it takes to re-build these every time you load a trace file, then you can select this in the Recording Options.

If the additional files ever become out of date (newer software structures from a new release, etc.) or if any of the files are lost or damaged, the software will rebuild a fresh version of the information.

4.13 Exporting a CATC Trace File

By default, PCIe Protocol Analysis saves CATC Trace files in the **.pex** format. However, you can export a CATC Trace to a file in any of the following other formats:

- Text
- Comma Separated Value (CSV)
- Generator file format

Exporting to Generator file format is a simple way to create a script file from your CATC Trace. Only PCI Express packets will be exported to a script. All transaction levels, including supported SSD decodes, can be exported to Text or CSV Text.

To export a CATC Trace file, select **File > Export**.

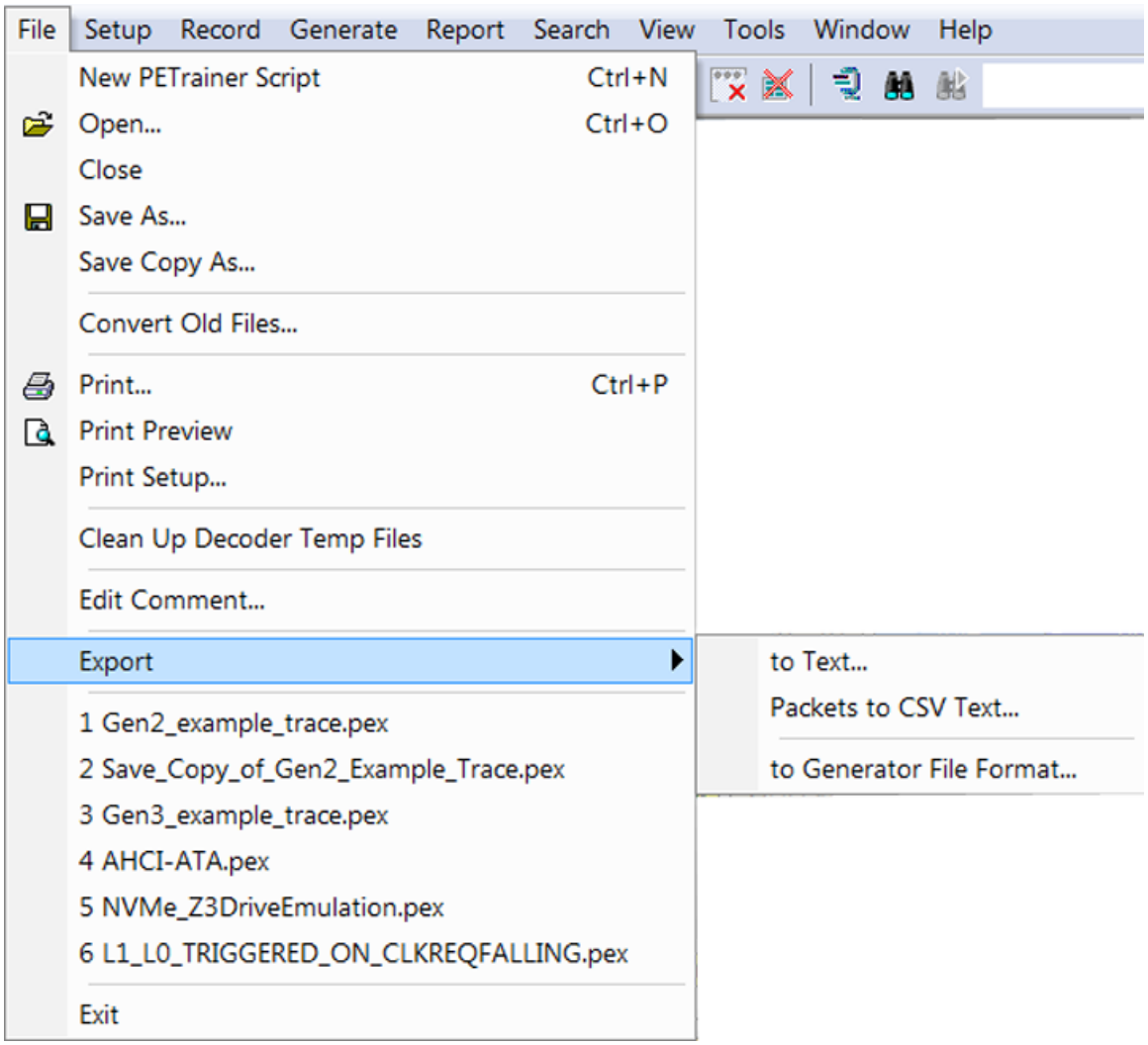


Figure 4.29: Exporting a File

4.13.1 Export: To Text

Select Export => To Text, a window pops up that has a button to select legacy format, which would not effect older scripts (see Figure 4.30) or to use the newer default format. See Figure 4.32 on page 204.

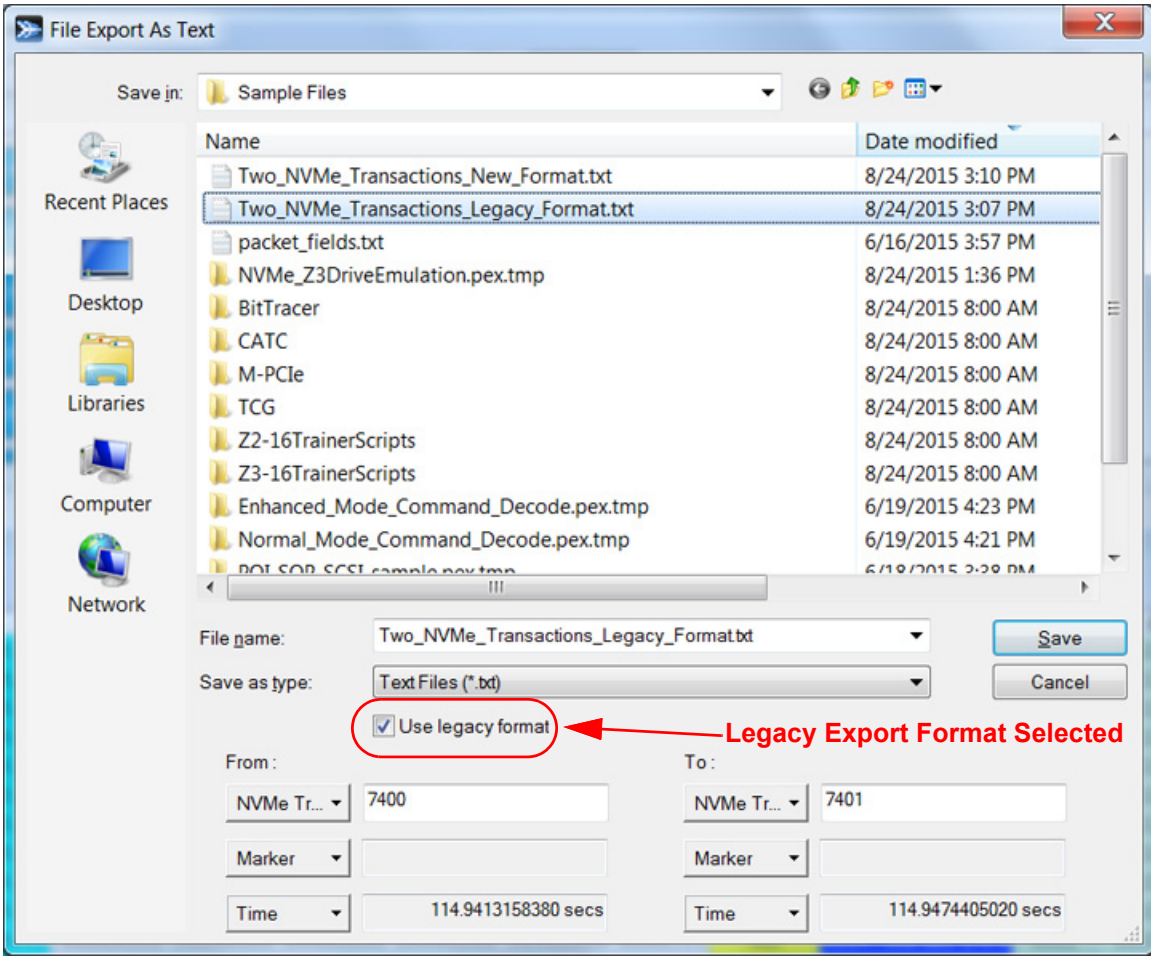


Figure 4.30: Export Two NVMe Transactions to Text File, Legacy Format

You can also select to Export only a portion of the Trace by setting the “From” and “To” menu items at the bottom of the dialog. You can select from Packets (or decoded Items see Figure 4.31) , Markers or Time see Figure 4.32 on page 204.

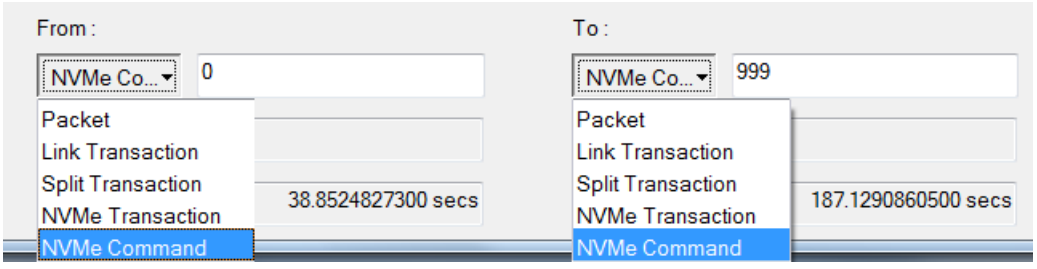


Figure 4.31: From and To Delimiters

The newer default format has the following characteristics:

- Removes spaces from time stamp format, i.e. "0002 . 742 651 908" -> 2.742651908
- Adds time delta value to the export
- Modifies 'Data' field to show '4 B' or 1 KB instead of '1 dword'
- QID / CID fields will be in decimal format rather than hexadecimal, i.e. 0x0007 -> 7

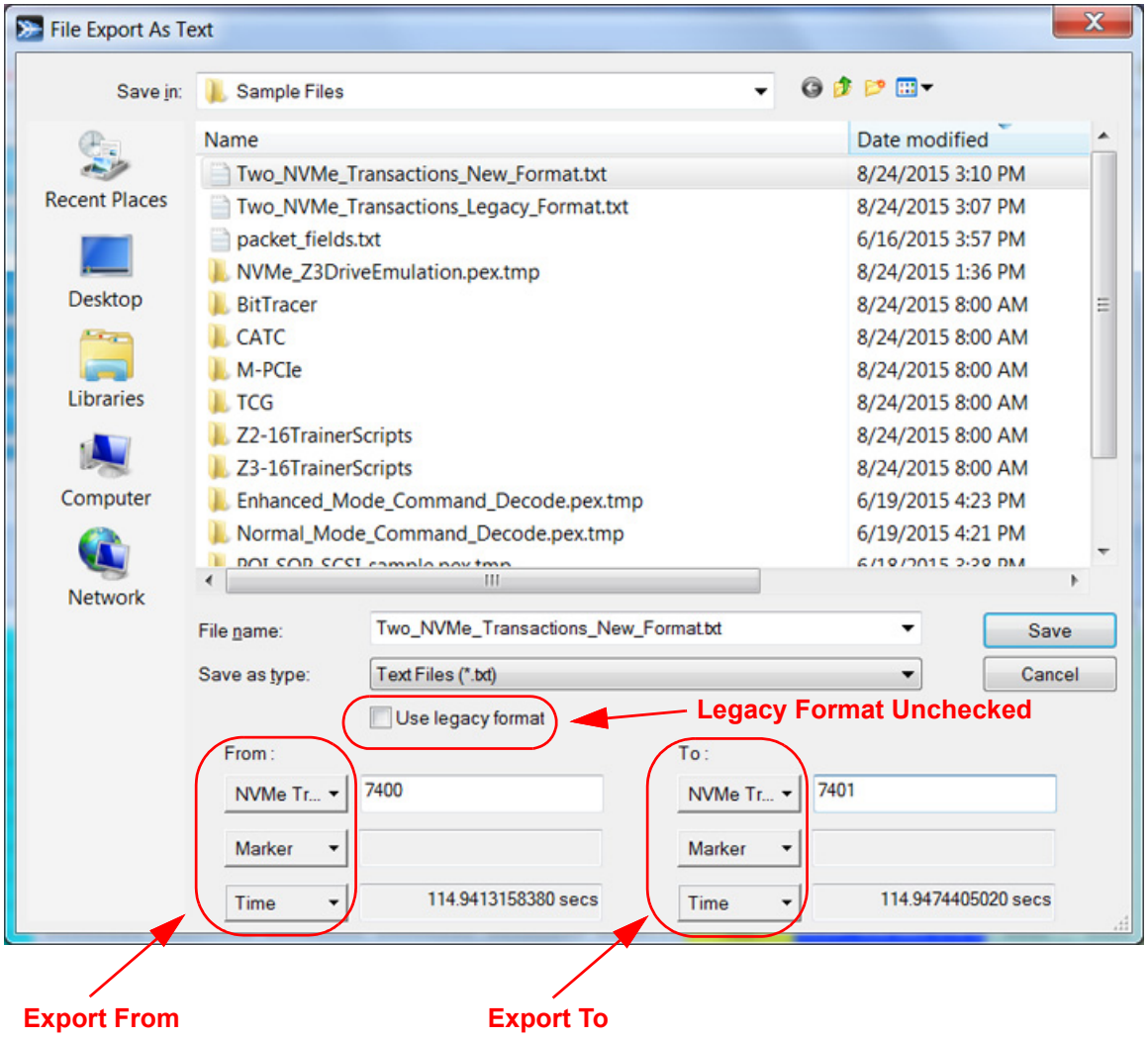


Figure 4.32: Export Two NVMe Transactions to Text File, New Format

You can see the differences in the two file formats below:

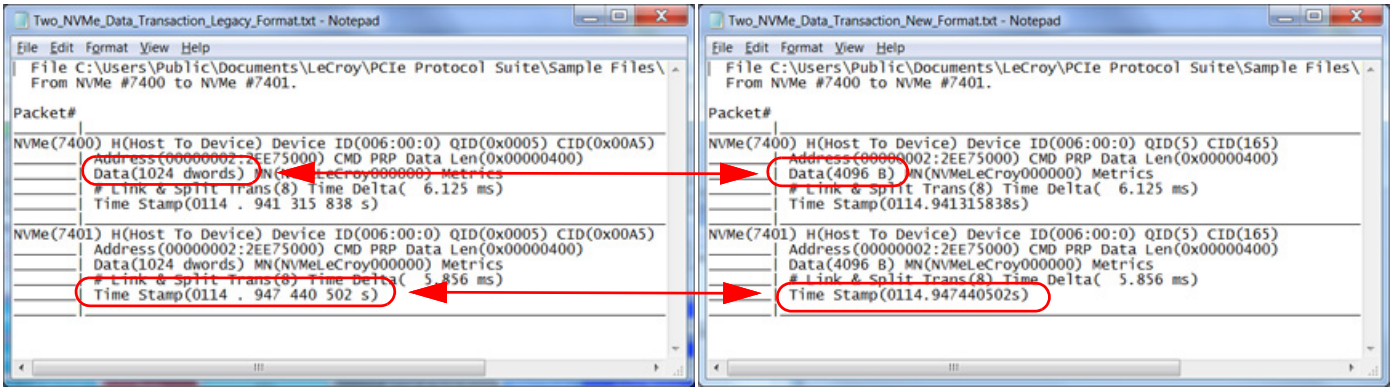


Figure 4.33: Export Trace Data to Text: Legacy vs New Format

4.13.2 Export: Packets to CSV Text

Now we'll Export Packets to CSV text using the legacy format, see Figure 4.34.

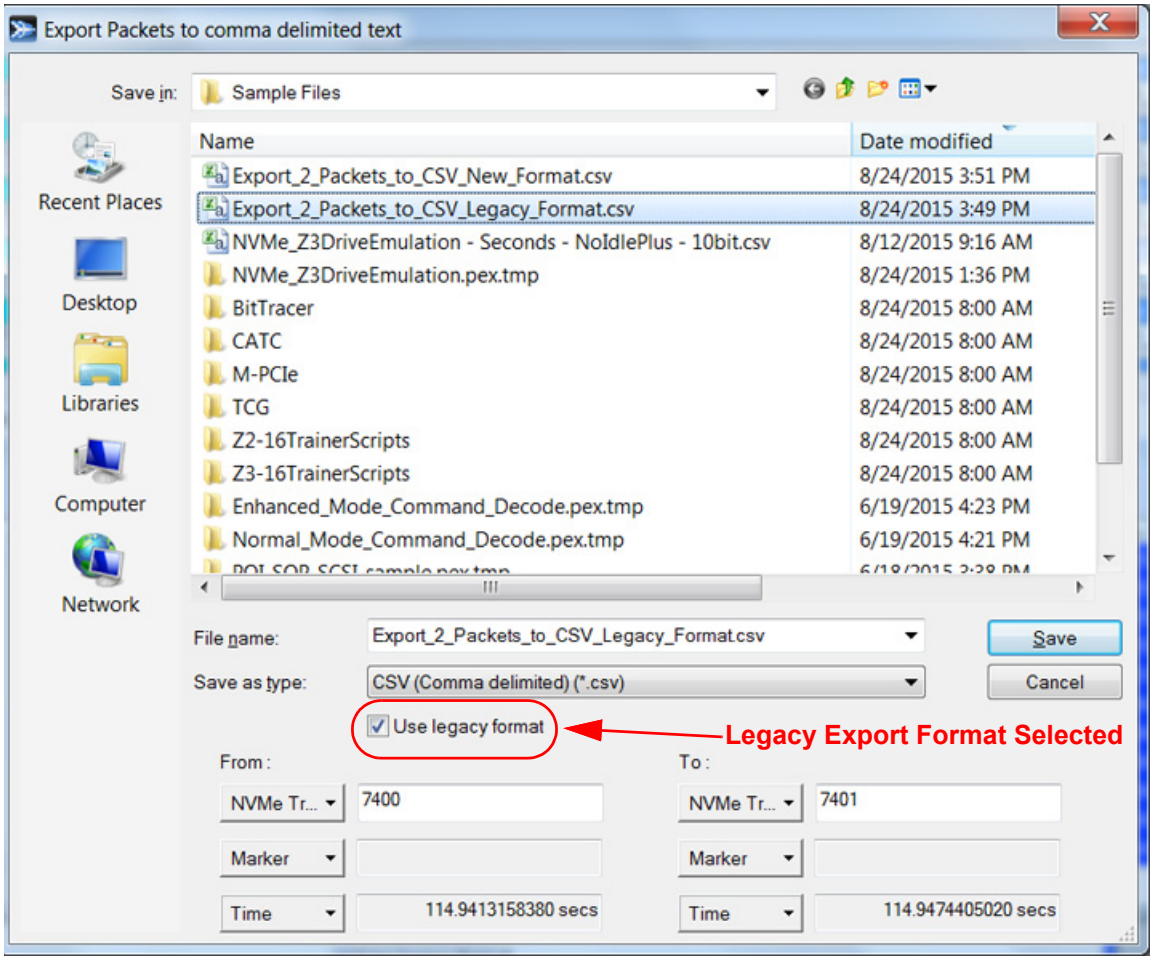


Figure 4.34: Export Packets to Comma Delimited Text: Legacy Format

Or we can export Packets to CSV text using the new format, see Figure 4.35.

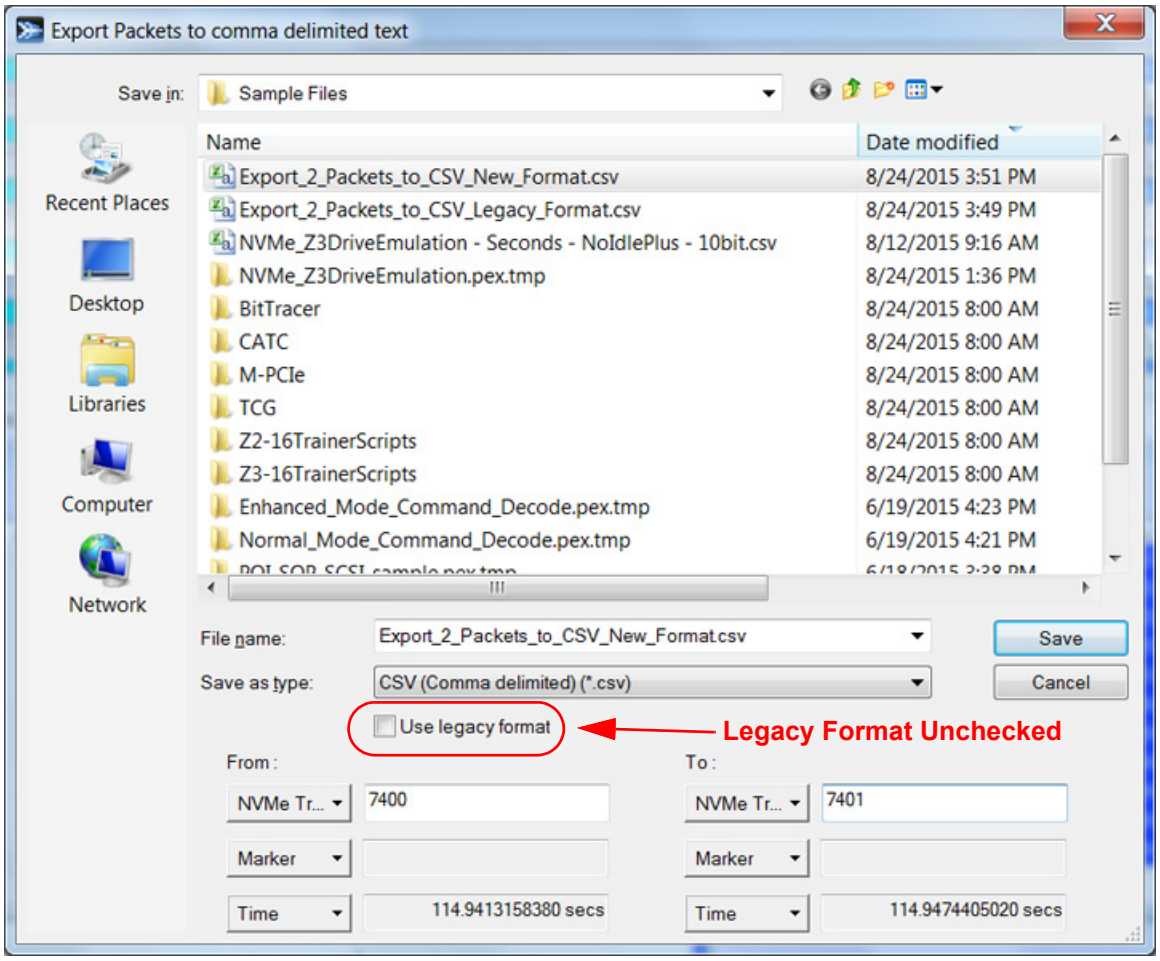


Figure 4.35: Export Packets to Comma Delimited Text: New Format

The differences in the two files can be seen in Figure 4.36.

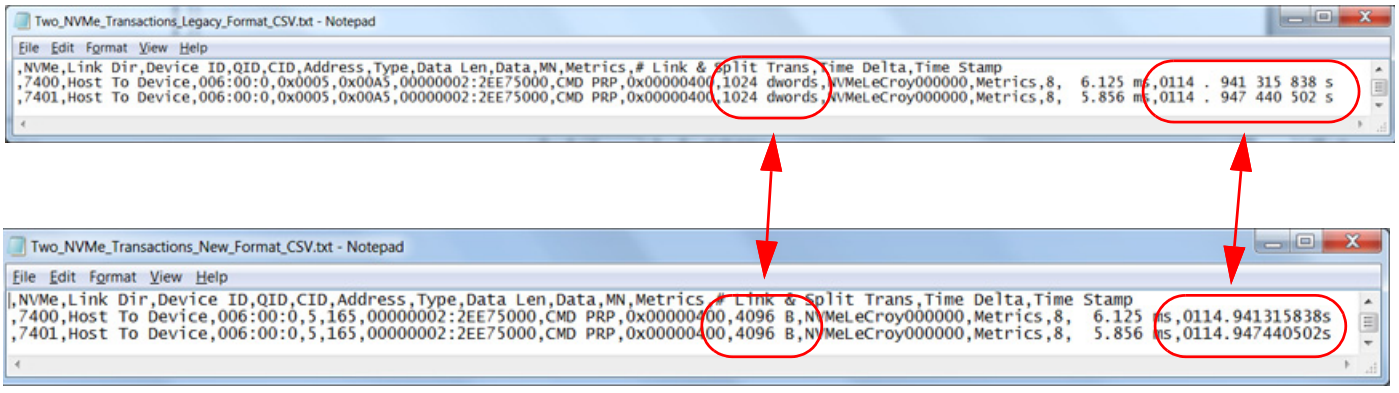


Figure 4.36: Export Packets to CSV Text: Legacy vs New Format

4.13.3 Export: To Generator File Format

To export a Trace File to Generator File format, choose that option. See Figure 4.37

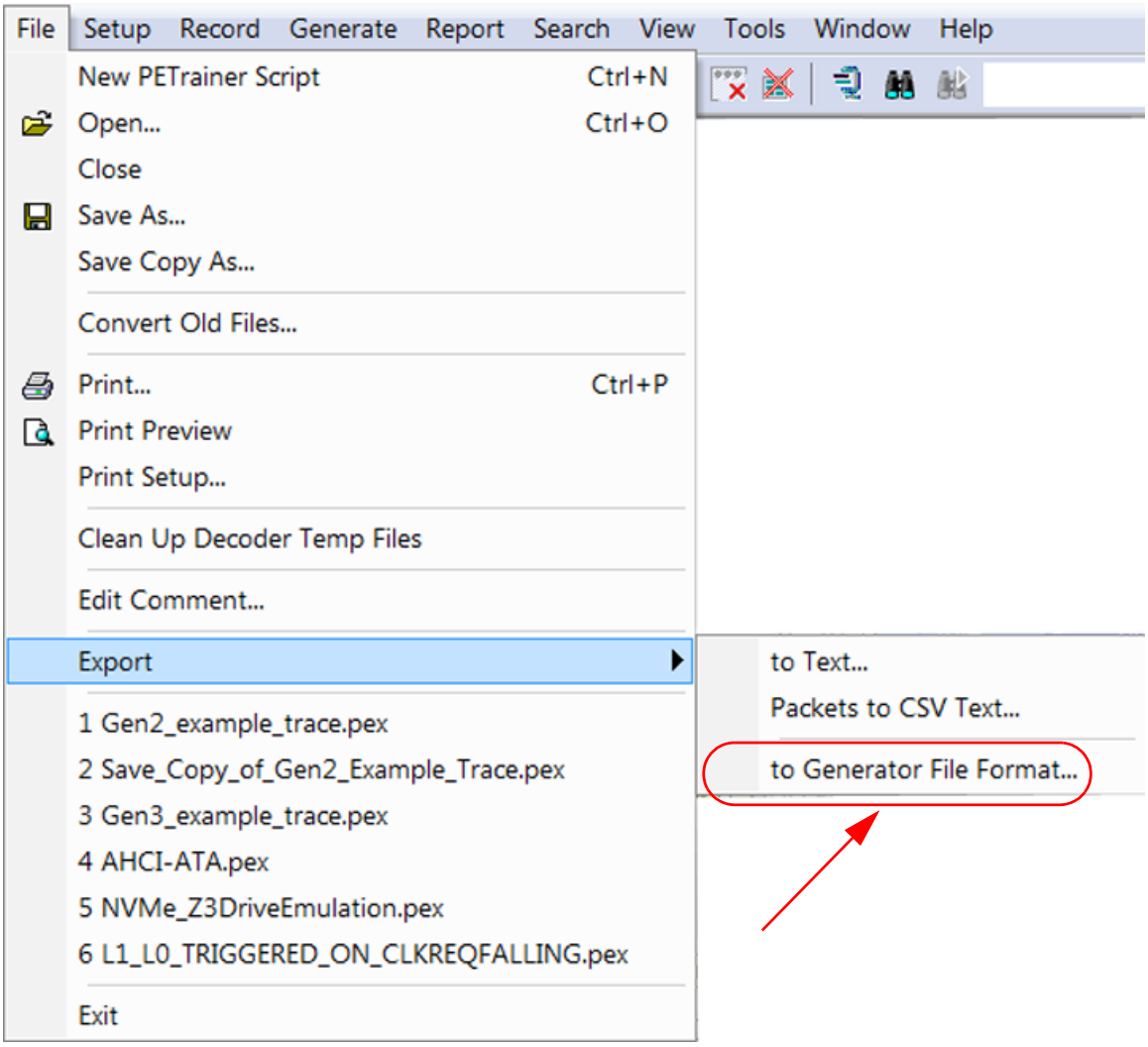


Figure 4.37: Export to Generator File Format

The purpose of Exporting a Trace file to Generator File Format is so that you can load that Generator file into a Teledyne LeCroy Exerciser (i.e. Z3-16) to generate data traffic to test a device.

4.13.3.1 Exporting a CATC Trace to a Traffic Generation File

A simple way to create a script file is to open a CATC Trace and then to export the CATC Trace data to a generation file:

1. Open a CATC Trace file.
2. Select **File > Export > to Generator File Format**.
3. Select the desired options from the File Export dialog box as shown below. See Figure 4.38 on page 208.

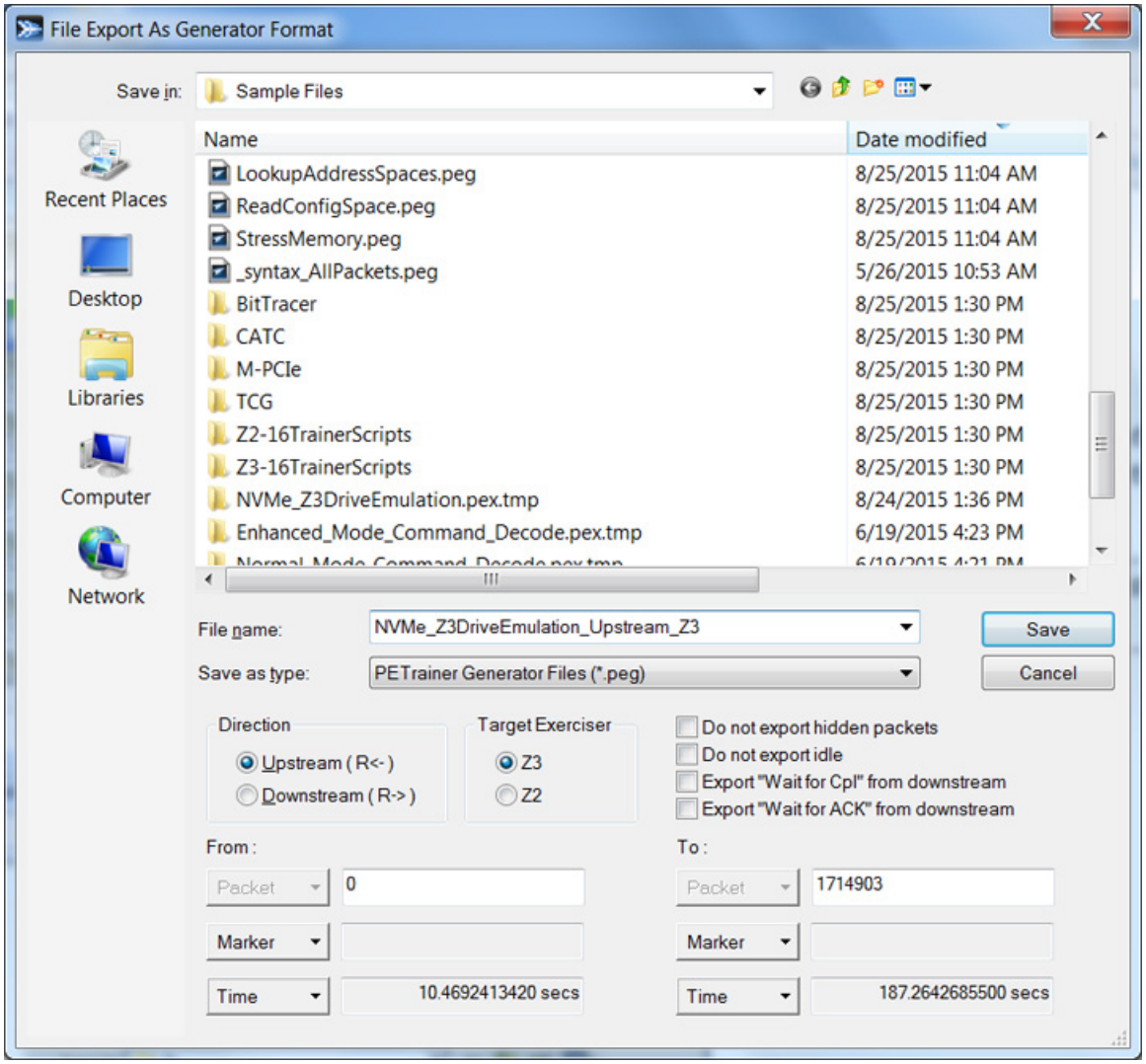


Figure 4.38: File Export As Generator Format Dialog.

Direction

Selects the direction of the traffic to be exported (Upstream or Downstream). In this case we chose Upstream. This will affect the Export “Wait for Cpl” and “Wait for ACK” options.

Target Exerciser

Select the type of Exerciser you plan to use (Z3 or Z2).

From and To

Selects a range for exporting. You can export all or part of the CATC Trace. You can select a range of Packets, Markers or Time.

Do not export hidden packets

Ignores any packets hidden through the various hide options.

Do not export Idle packets

Excludes Idles from the export.

Export "Wait for Cpl" from downstream

Exports all **Wait for Completions** from the opposite direction. **Wait = TLP** is a script command.

Export "Wait for ACK" from downstream

Exports all **Wait for ACK DLLPs** from the opposite direction.

4.13.4 Export From Data Flow View

You can also Export Trace Data from the Data Flow view (see Figure 4.39, Figure 4.40 on page 210 and Figure 4.41 on page 211) in either the Legacy or New data format.

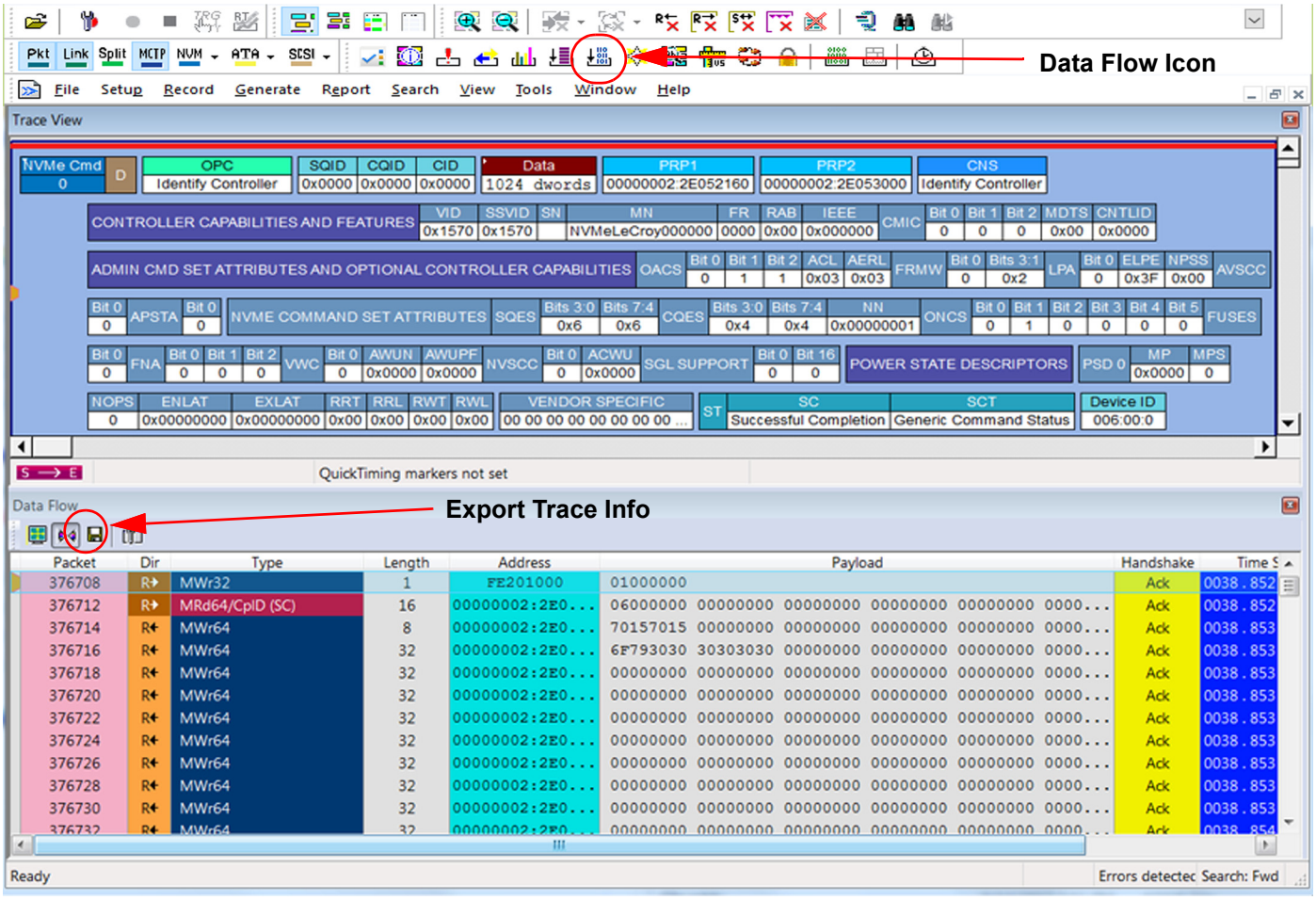


Figure 4.39: Data Flow View: Export by Selecting Save Icon

Export the Data Flow View information by selecting the Save icon. A new window will pop up where you can decide on the file name and path as well as whether the New data file format or the Legacy data file format is used. In this first example, we've chosen the Legacy format. See Figure 4.40.

4.13.4.1 Data Flow CSV File: Legacy Format

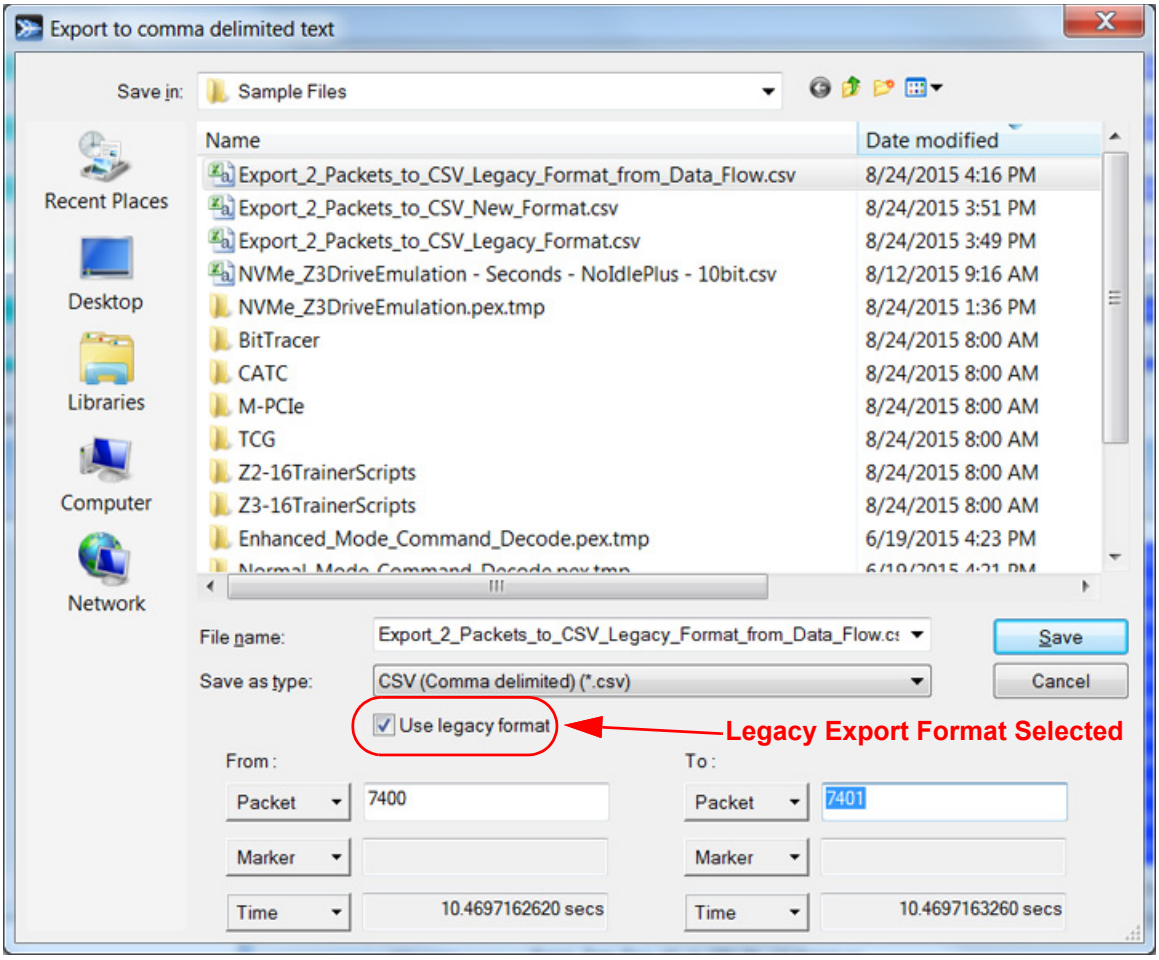


Figure 4.40: Data Flow View: Export Packets to Comma Delimited Text: Legacy Format

4.13.4.2 Data Flow CSV File: New Format

Next we'll chose the New Data format for the CSV file. See Figure 4.41.

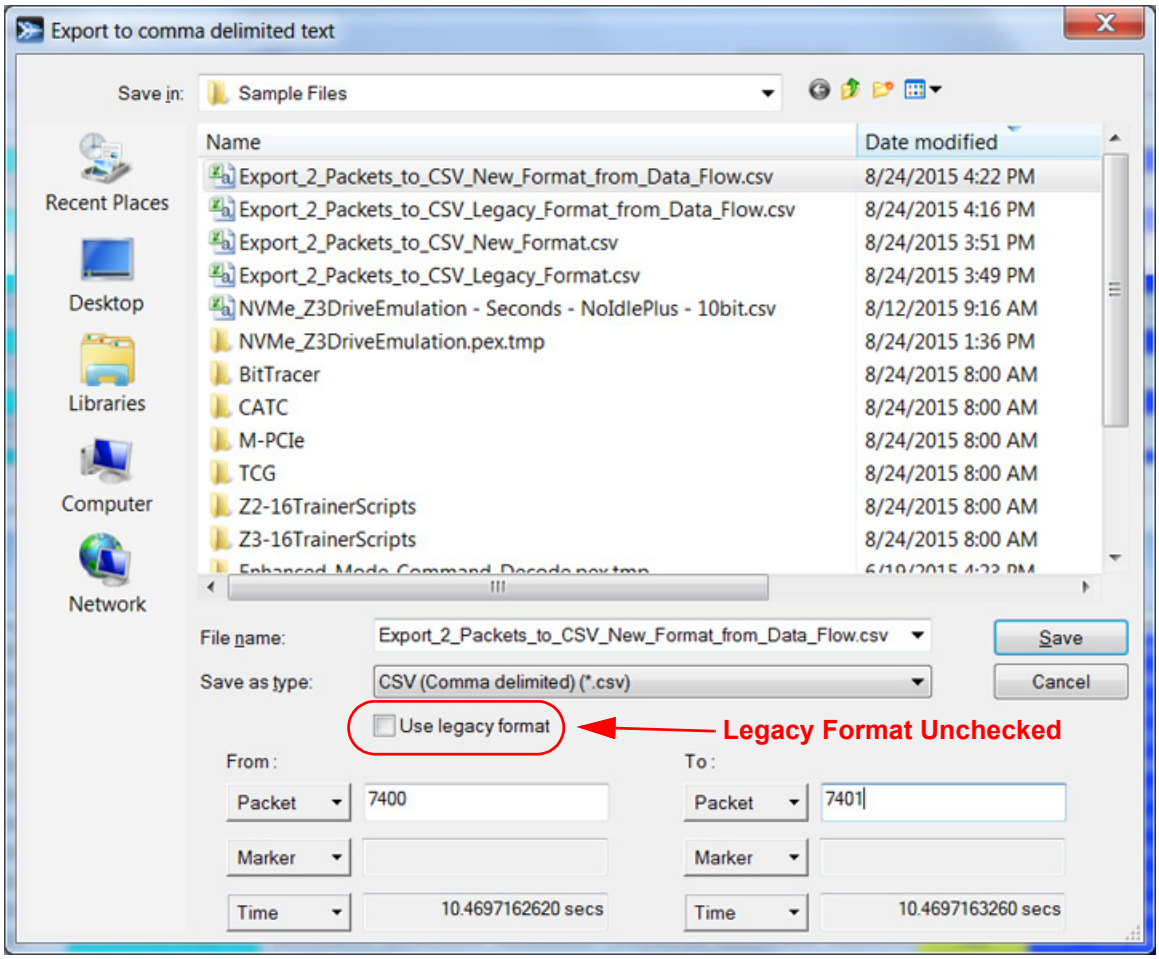


Figure 4.41: Data Flow View: Export Packets to Comma Delimited Text: New Format

4.14 Printing Data Files

To print all or part of the open CATC Trace:

1. Select **File > Print** from the menu or

   click the **Printer**  button on the toolbar.
   The Print Packets dialog displays (see Figure 4.42 on page 212).

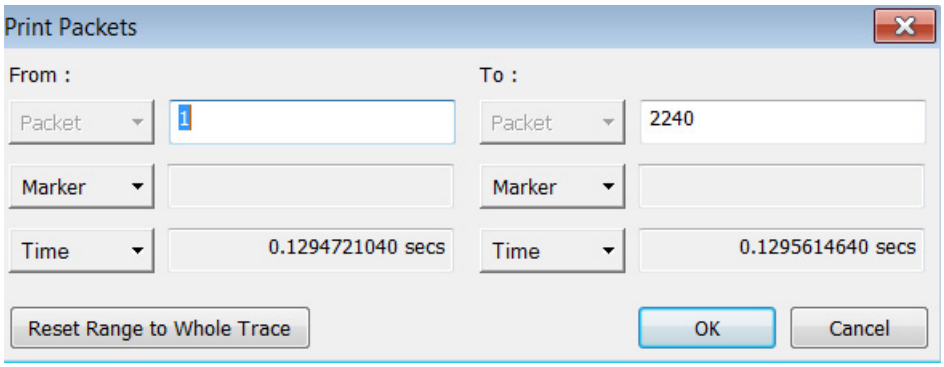


Figure 4.42: Print Packets Dialog

2. To select a range of packets, enter values in the **From packet #** and **To packet #** fields and click **Print**.
3. To print an entire file, leave the From and To fields empty and click **Print**.

The specified traffic information is printed as currently displayed, in color or gray scale as supported by your printer. Any CATC Trace File comments you entered are printed following the current document name at the top of each page.

Note: CATC Trace File comments can be created by using **Edit Comment** on the File menu.

4.15 Analyzer Chat Window

PCIe Protocol Analysis has a Chat window that allows you to communicate with users on remote host machines. For Chat to work, two conditions must be met:

- The host machines must have PCIe Protocol Analysis installed and running.
- The host machines must be listed in each other's All Connected Devices list. This means that your host machine must have the remote host machine listed in its Analyzer Devices window and the remote host machine must have your host machine listed in its Network Browse window. See Figure 4.43 on page 213.

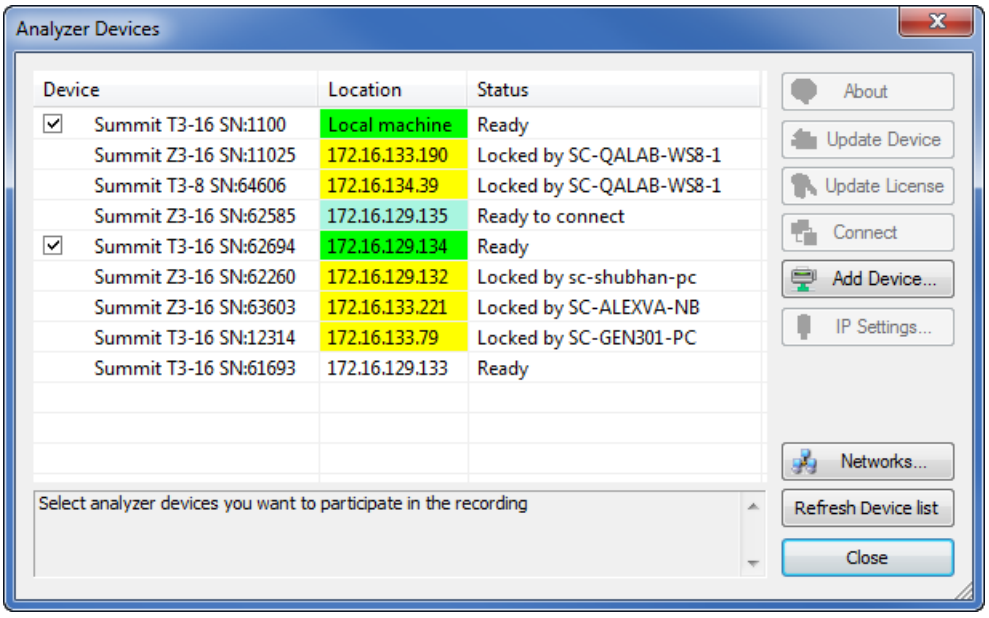


Figure 4.43: Analyzer Network Dialog

If the above conditions are met, a Chat session is initiated by running the command: **View > Analyzer Network Chat Bar**. The following dialog box opens.

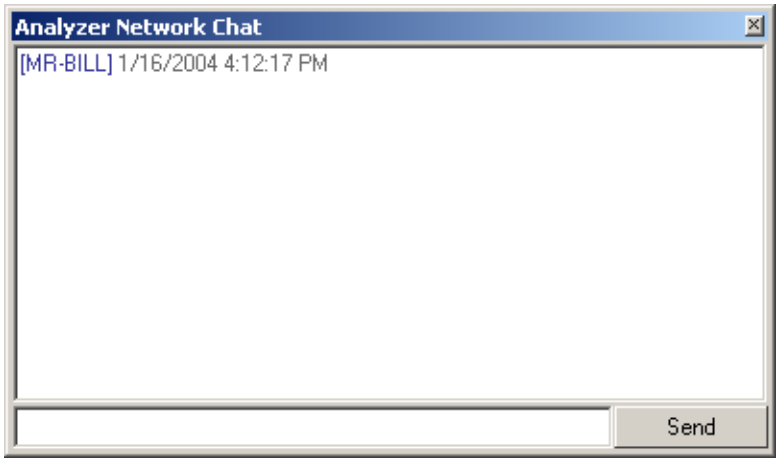


Figure 4.44: Analyzer Network Chat Dialog

Enter some text, then press **Send**. The message is then broadcast to all host machines listed in your network browse window. If a target host machine also lists your host machine in its Network Browse window, then it can receive your message. When the message arrives, the Chat window automatically opens.

4.15.1 CrossSync Control Panel

The CrossSync Control Panel allows you to select analyzers for synchronization and manage the recording process. It supports a wide combination of Teledyne LeCroy's flagship analyzers including PCI Express, USB, DDR, Serial ATA (SATA), Serial Attached SCSI (SAS), Fibre Channel (FC) and Ethernet.

CrossSync is Teledyne LeCroy's analyzer synchronization solution that enables time-aligned display of protocol traffic from multiple daisy-chained analyzers showing packet traffic from multiple high-speed serial busses. A lightweight software control panel allows users to select analyzers for synchronization and manage the recording process. Captured traffic is displayed using the latest analyzer software (in separate windows) with all the protocol specific search and reporting features.

Captured packets are displayed in separate windows that share a common time scale. Navigating the traffic in either direction will scroll to the same timestamp in a synchronized window. When using the CrossSync option, users can access the full complement of analysis capabilities available within the individual Teledyne LeCroy software. Search, reporting, and decoding all operate normally.

This feature is available with the Teledyne LeCroy PCIe Protocol Analysis application.

4.15.1.1 Launching the CrossSync Control Panel

To launch CrossSync from the PCIe Protocol Analysis application, select the '**Launch CrossSync Control Panel**' entry in the 'Setup' menu (see the screen below). Or, you can launch CrossSync from the '**Start**' menu.

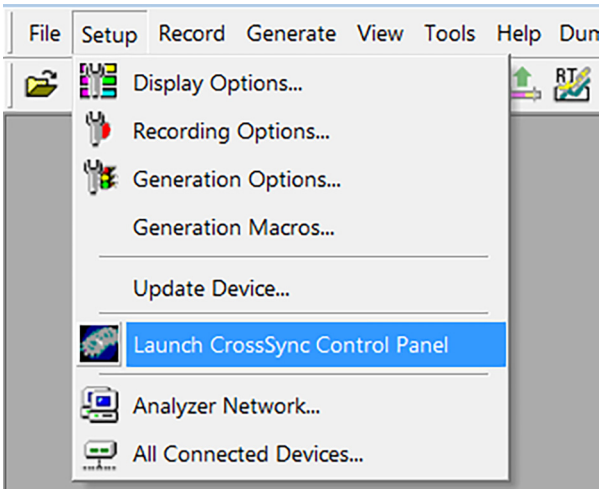


Figure 4.45: Launching CrossSync from the PCIe Protocol Analysis Application

Please refer to the *CrossSync Control Panel User Manual* for more information.

Chapter 5

Recording Options

5.1 Recording Overview

After installing the software, the recording options should be set prior to recording. The recording options define the behavior of the Summit Analyzer during recording. You can create, save and load previously saved recordings. This section explains how to define recording options on the Summit T3-16 and T3-8 Analyzers (see Figure 5.1 on page 217). The following section describes the NVMe recording options available on the Summit T34 Analyzer (see Figure 5.2 on page 218). The Summit T28 and Summit T24 analyzers have similar recording options (see Figure 5.3 on page 219).

5.2 General Tab

5.2.1 Summit T3-16 Analyzer

The Recording Options dialog is used to configure a recording.

To open the Recording Options window, click  or select the command **Setup > Recording Options**.

Note: There are separate sets of Recording Options for each Analyzer type. To set the Analyzer type, select the appropriate platform from the Target Analyzer menu in the General tab of the Recording Options.

The General tab displays options that affect all recordings (see Figure 5.1 on page 217).

5.2.1.1 Recording Options-General Tab: T3-16

This section describes the General Tab recording options.

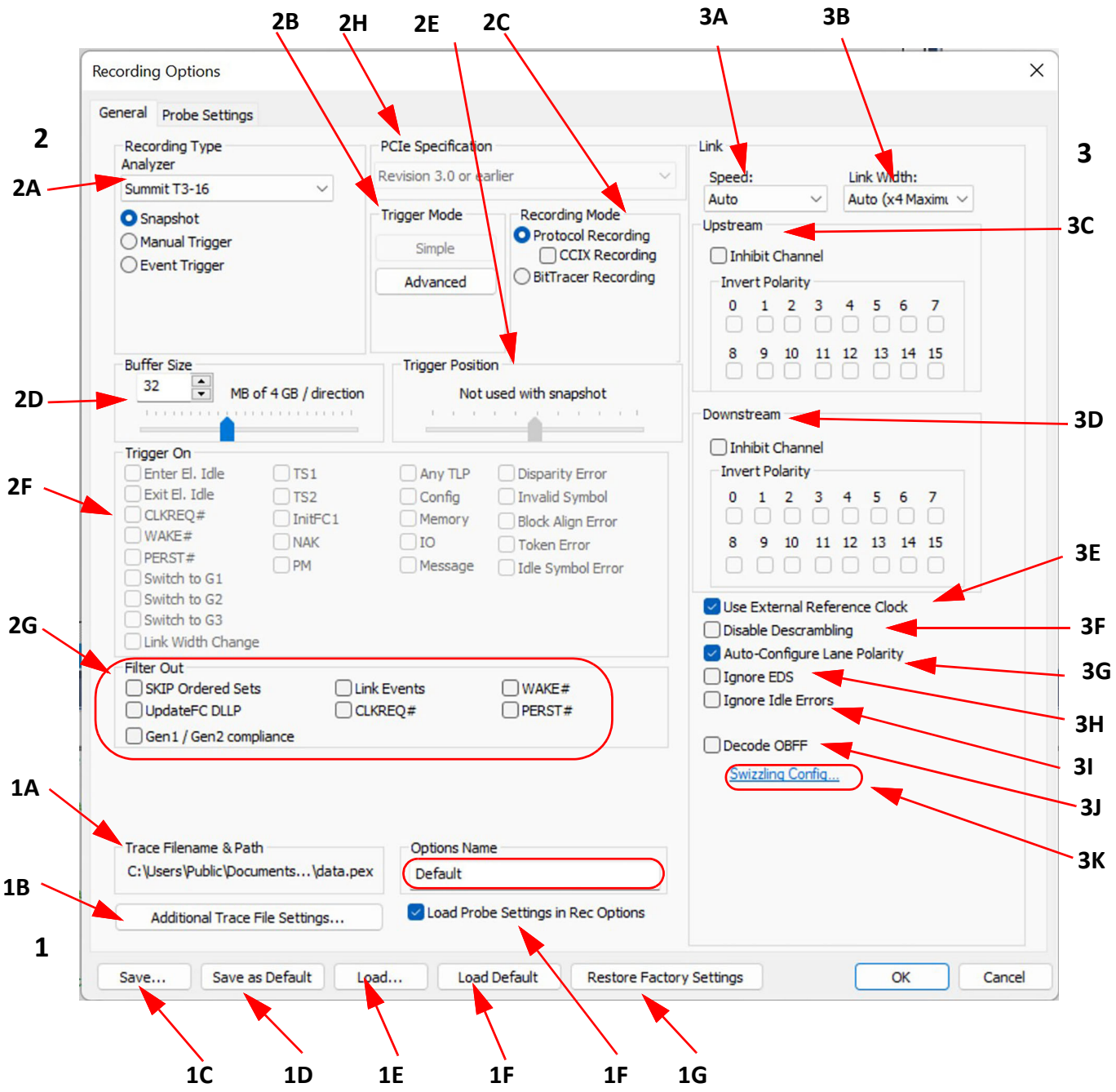


Figure 5.1: Summit T3-16 Recording Options

Note: Recording Options for the T3-8 are similar but vary in link width.

Note: Please refer to the figure callout numbers in each of the sections below to co-relate to Figure 5.1 shown above. For instance, for Simple and Advanced Mode, see Figure 5.1: 1B.

5.2.2 Recording Options-General Tab: T34

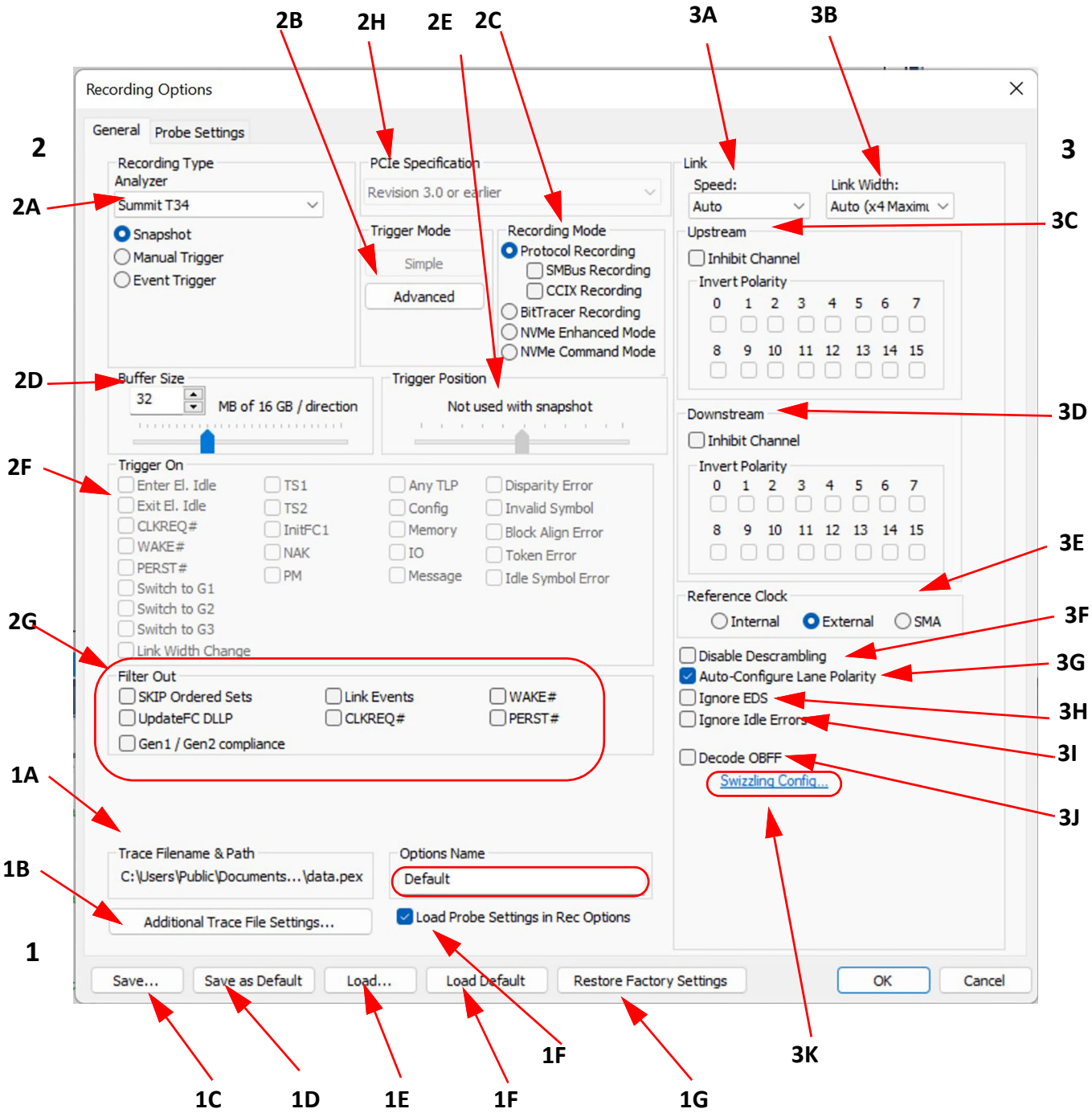


Figure 5.2: Summit T34 Recording Options

5.2.3 Recording Options-General Tab: T28

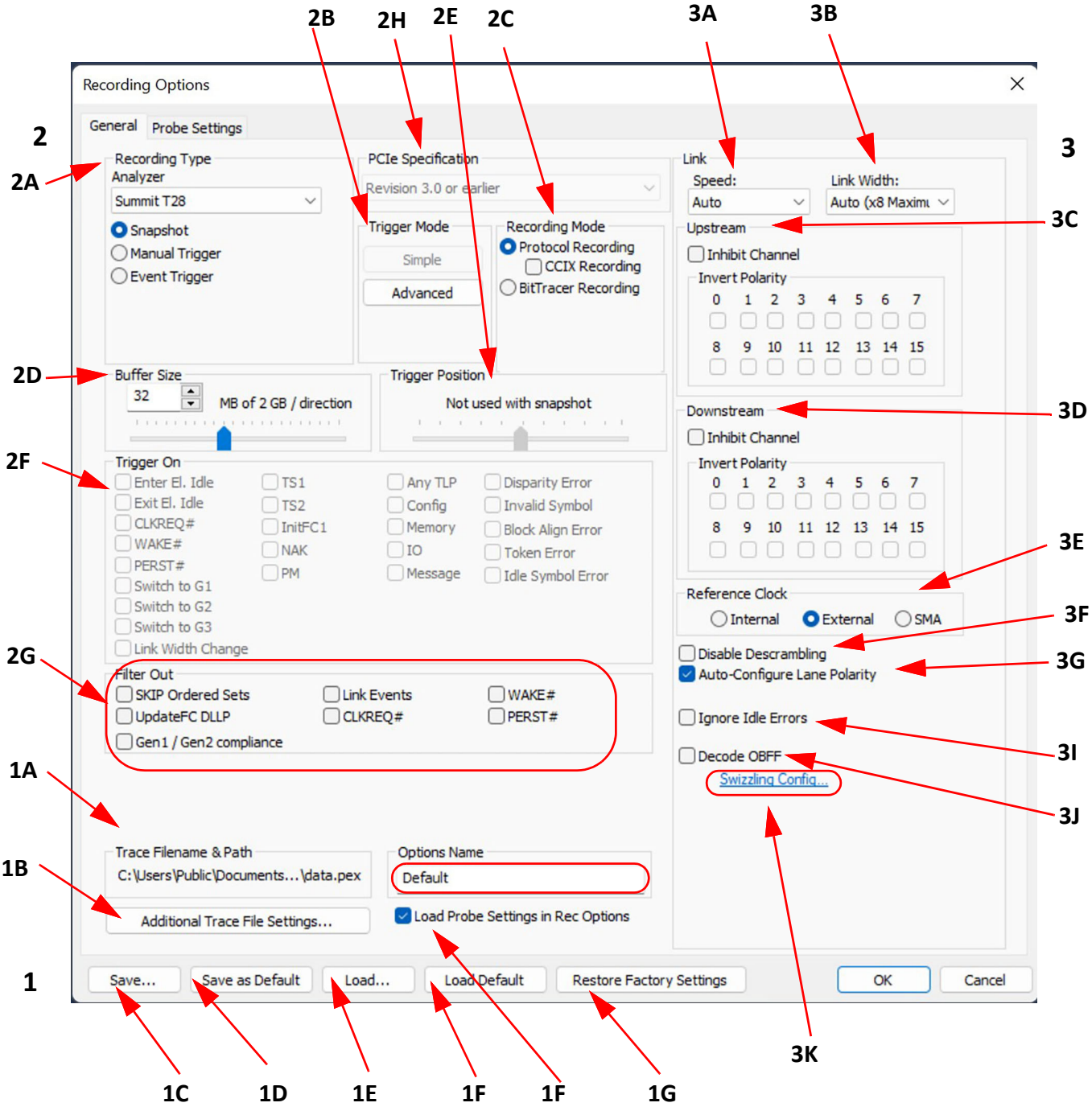


Figure 5.3: Summit T28 in Recording Options.

Note: Recording Options for the T24 are similar but vary in link width and the Reference Clock is limited to Internal and External only.

5.3 Simple and Advanced Mode

The **Trigger Mode** panel displays the modes available: Simple or Advanced. The Simple Mode allows quick access to commonly used options. The recording options are the same in both modes (See Figure 5.1 on page 217: 2B).

To change between the modes, simply click the **Simple** button for Simple mode, or click the **Advanced** button for Advanced mode.

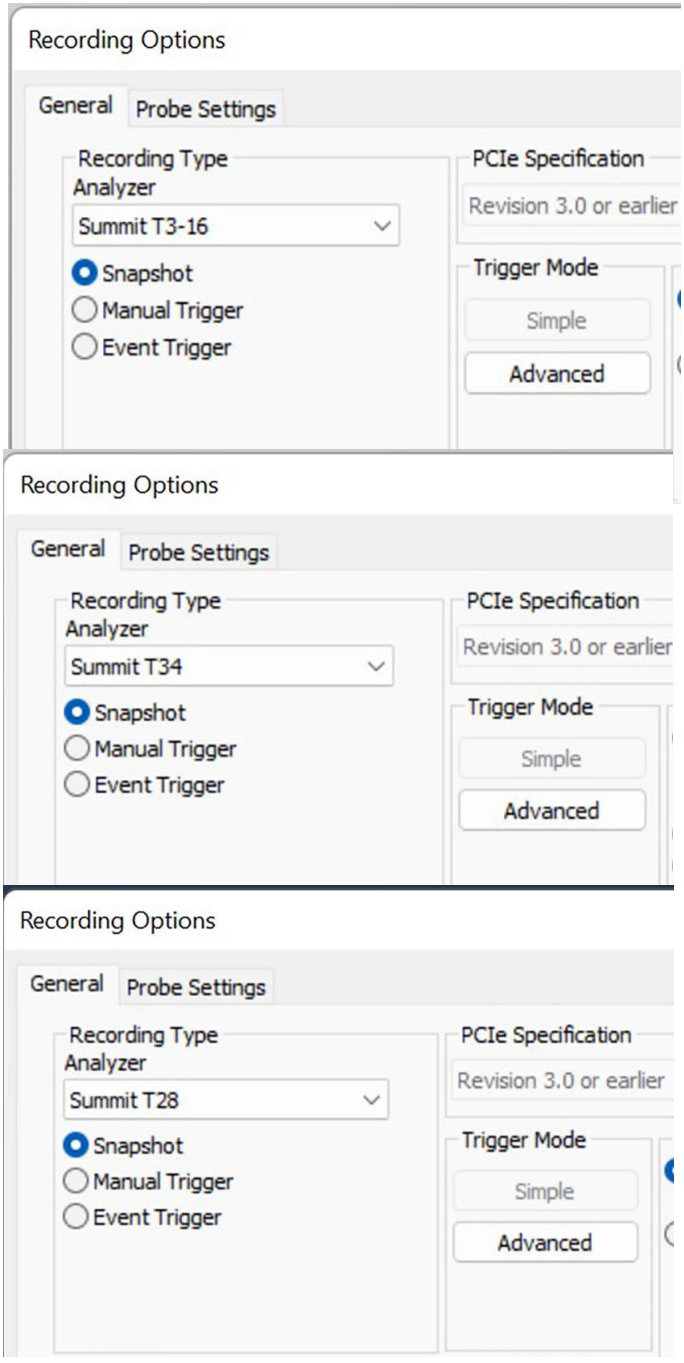


Figure 5.4: Switch to Simple/Advanced Mode Button -> T3-16, T34, T28

5.3.1 Options in Advanced Mode: Disable Auto Channel Swap

One Recording Option that becomes available in Advanced Mode is Disable Auto Channel Swap. See Figure 5.5.

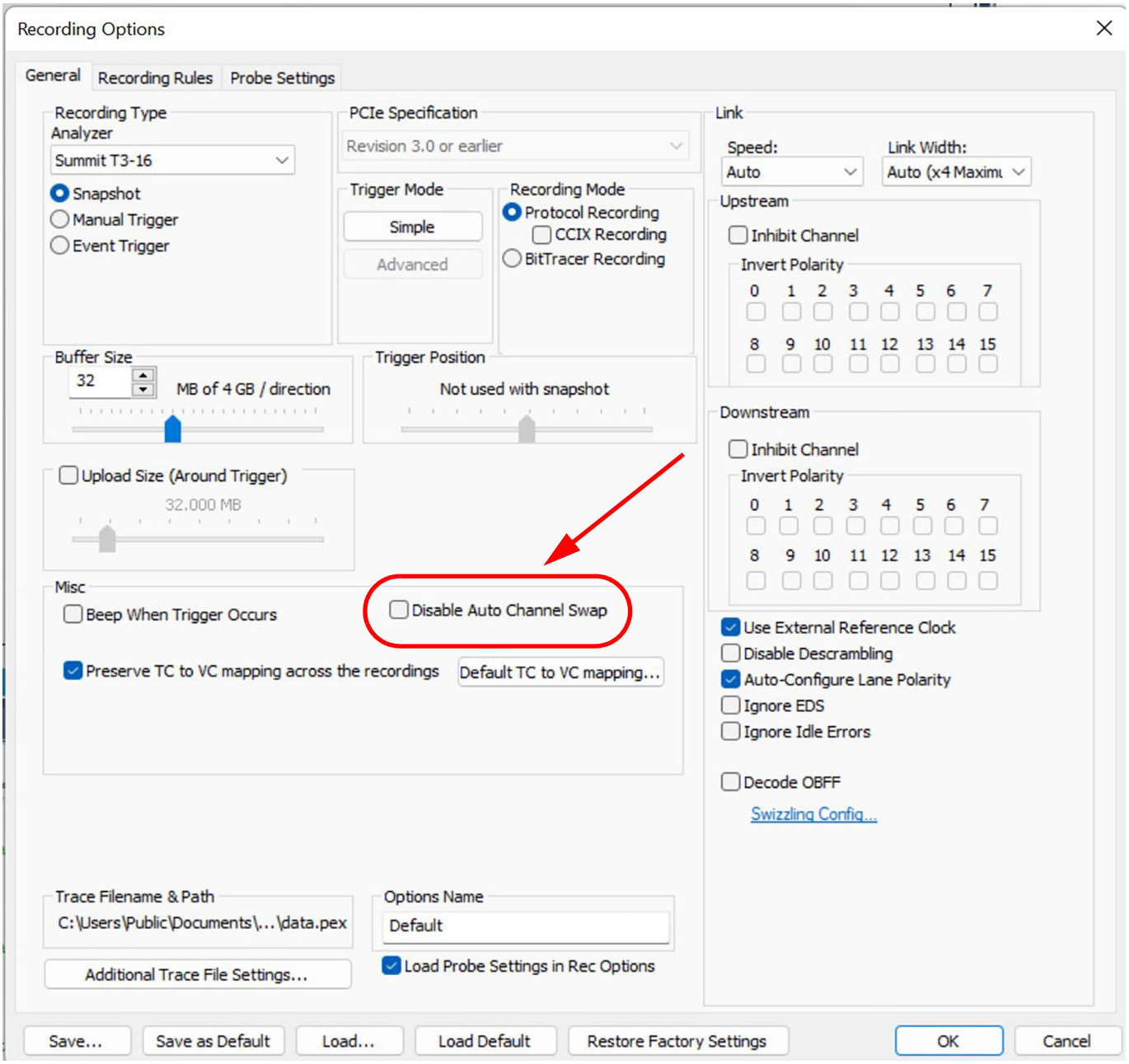


Figure 5.5: Recording Options: Advance -> Disable Auto Channel Swap

If Disable Auto Channel Swap **is not selected,** the PCIe Analysis software will swap the direction of the traffic data based on it's internal analysis of the traffic on the bus (channel direction swapping is enabled).

If Disable Auto Channel Swap **is selected**, the PCIe Analysis software will record the traffic data as the Summit analyzer sees it and this depends on the way the connections were

made to probe the bus (channel direction swapping is disabled).

5.3.2 Options in Advanced Mode: TC to VC mapping

One Recording Option that becomes available in Advanced Mode is TC to VC mapping. See Figure 5.6.

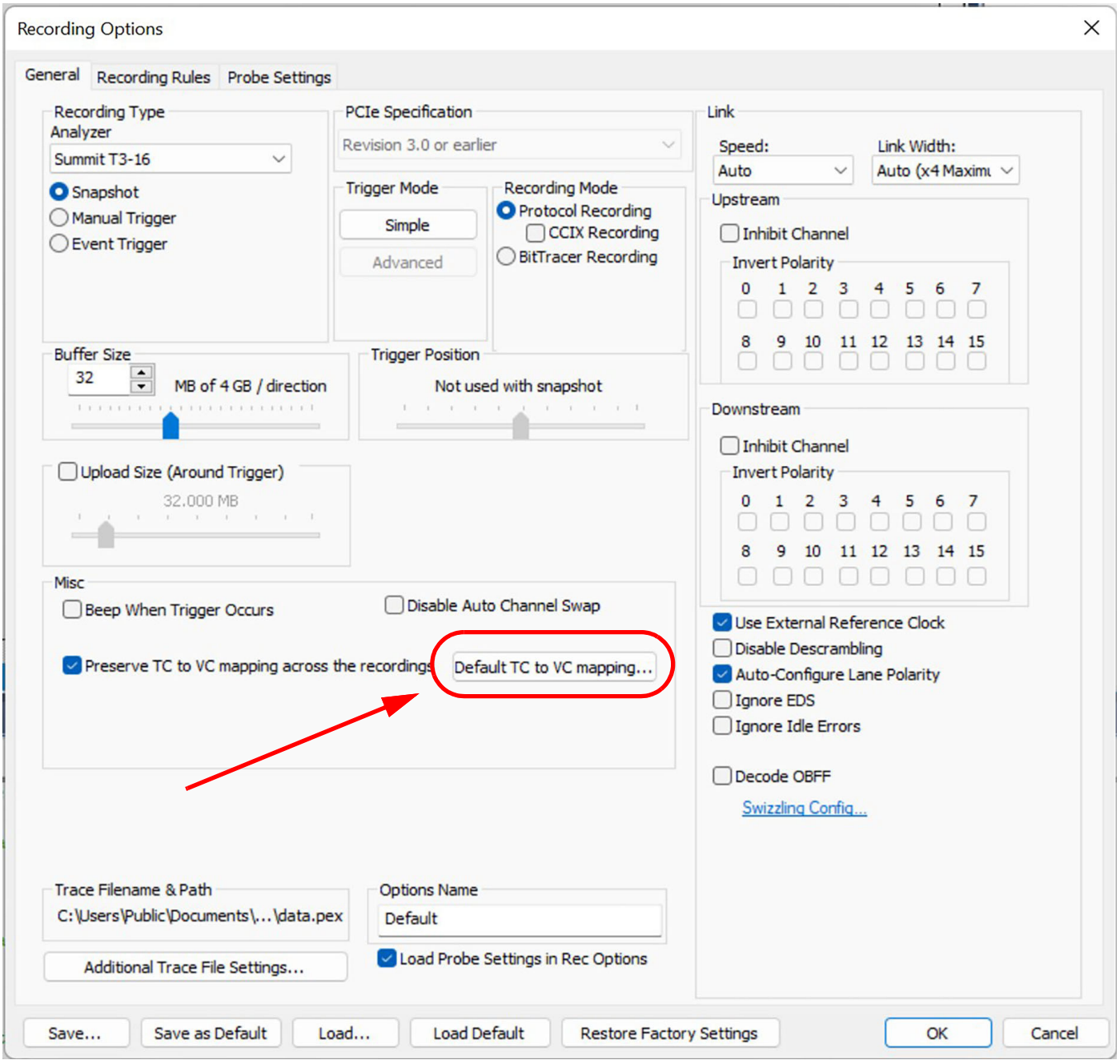


Figure 5.6: T416 Advanced Recording Mode: Default TC to VC mapping

If you select Default TC to VC mapping, the following dialog box pops up and you can manipulate the TC to VC mapping. See Figure 5.7 on page 225.

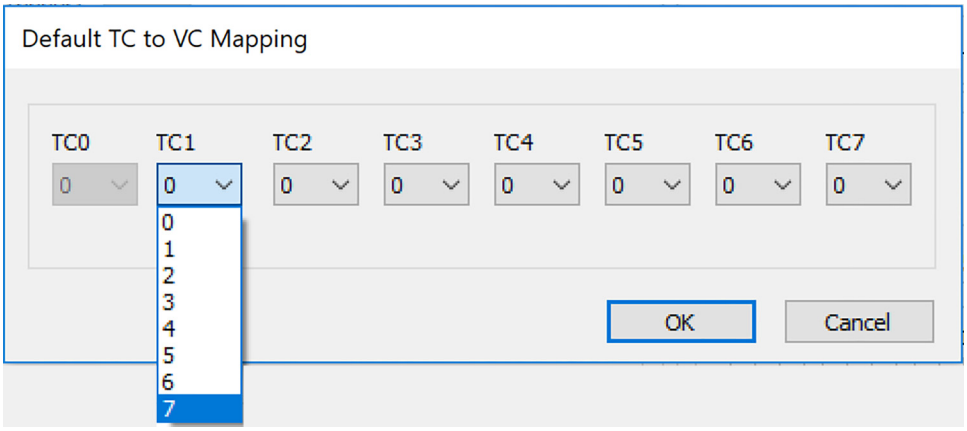


Figure 5.7: TC to VC Mapping

5.4 Trace Filename and Path

The Trace Filename and Path button sets the path and CATC Trace name for the recording. It allows you to change the default file name and path for the recorded CATC Trace file. The pre-defined name is **data.pex**. See Figure 5.1 on page 217: 1A.

1. Select the **Recording File Name** button.
2. The Specify Trace File Name dialog opens to navigate to the directory you want.
3. Enter the new file name in the File name field.
4. Click the **Save** button.

   This action does not do any immediate save operation. It just changes the default name and uses it in subsequent recordings.

5.5 Saving and Loading Previously Saved Recording Options

You can save a recording or load previously saved recordings. In the general tab the following Save options are available (see Figure 5.1 on page 217).

5.5.1 Setting Default Recording Options

To save the current recording options into the default Recording Options file:

Click **Save As Default**. The default file for the options is **default.rec**.

When the PCIe Protocol Analysis begins execution, it automatically loads the **default.rec** file, if one exists.

Options Name: See Figure 5.1 on page 217: 1F

The Options Name is a descriptive, supplemental label that you can assign to a Recording Options file so you can easily recall what settings are in the Recording Options file.

For example, if your Recording Options file were named **StandardSettings.rec**, your Options Name could be a long descriptive label such as **Standard Record Options used for all normal Recordings**.

Save: See Figure 5.1 on page 217: 1C

Saves the current options to whatever file name you provide.

Save As Default: See Figure 5.1 on page 217: 1D

Saves the current options into the default options file. This file is called **default.rec** or any other name you have assigned to the default options file. Whenever the Teledyne LeCroy PCIe Protocol Analysis begins execution, it automatically loads the default file, if one exists.

Load: See Figure 5.1 on page 217: 1E

Loads a previously saved set of recording options.

OK

Applies changes and closes the Recording Options dialog.

Cancel

Cancels changes and closes the Recording Options dialog.

5.5.2 Load Probe Settings in Recording Options

By default this checkbox is selected (see Figure 5.1 on page 217: 1G), which will load a probe settings file that you have generated.

If the “Load Probe Settings In Rec Options” checkbox is not selected the default probe settings are used. See Figure 5.8.

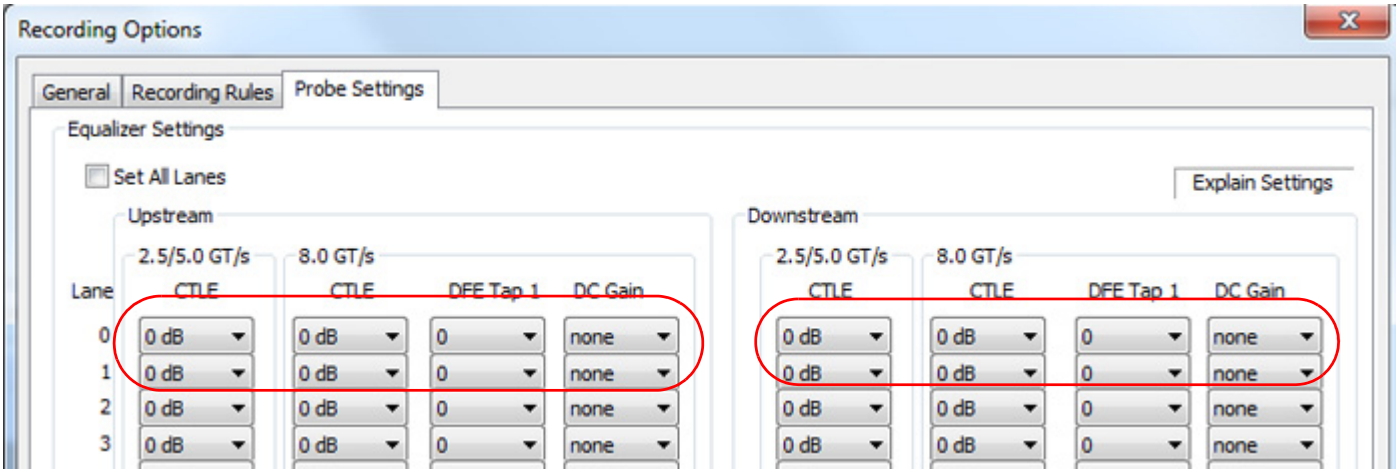


Figure 5.8: Default Probe Settings

If the you select the Probe Settings tab, update the values for the probes on specific lanes (see Figure 5.9) and then store them (see Figure 5.10 on page 230), your values will be used the next time you set up the Recording Options (with the “Load Probe Settings in Rec Option” checkbox selected) instead of the default values.

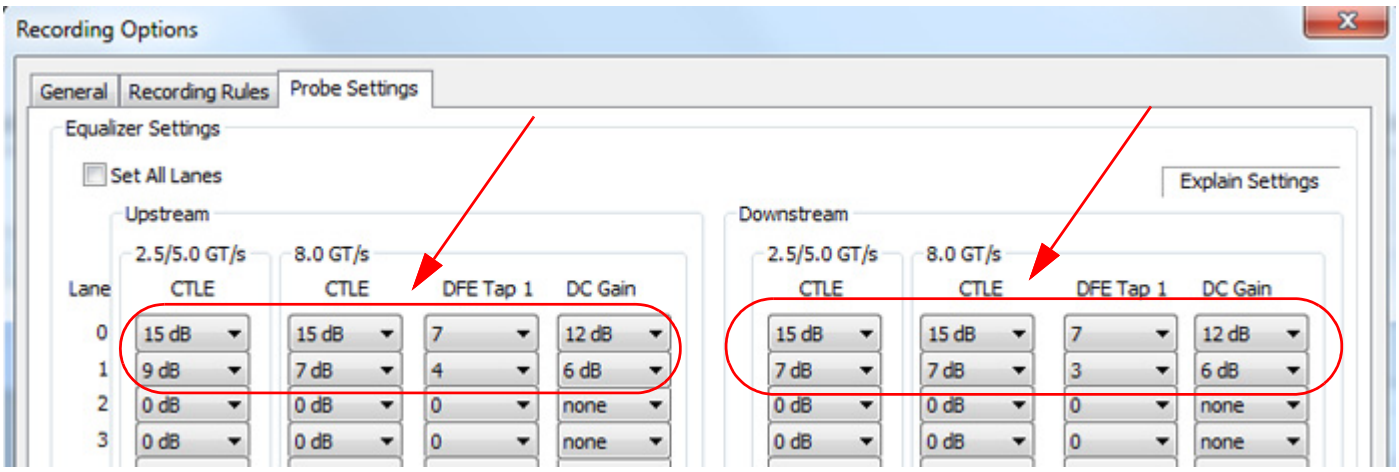


Figure 5.9: User Defined Probe Settings

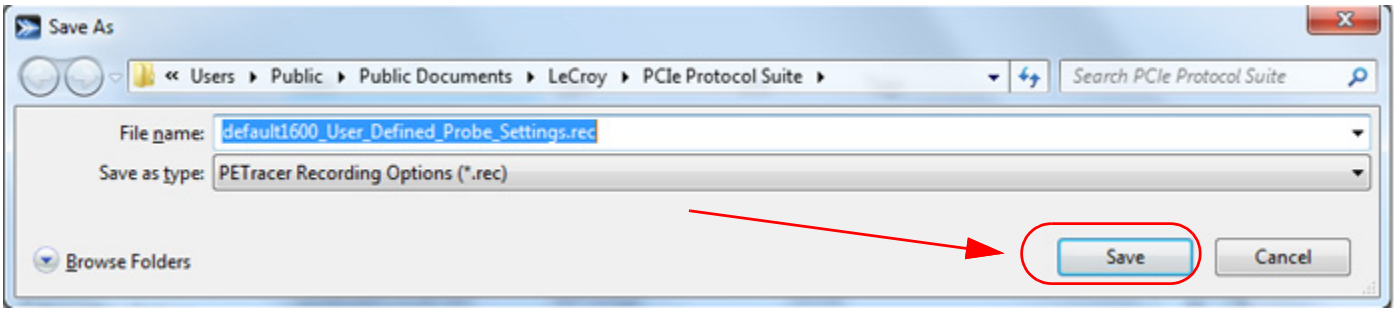


Figure 5.10: User Defined Probe Settings File: Saved

When you set up the Recording Options at a later date and have the “Load Probe Settings In Rec Options” checkbox selected, select the Load button and you can select which set of Probe Settings you want to use. See Figure 5.11 and Figure 5.12 on page 231.

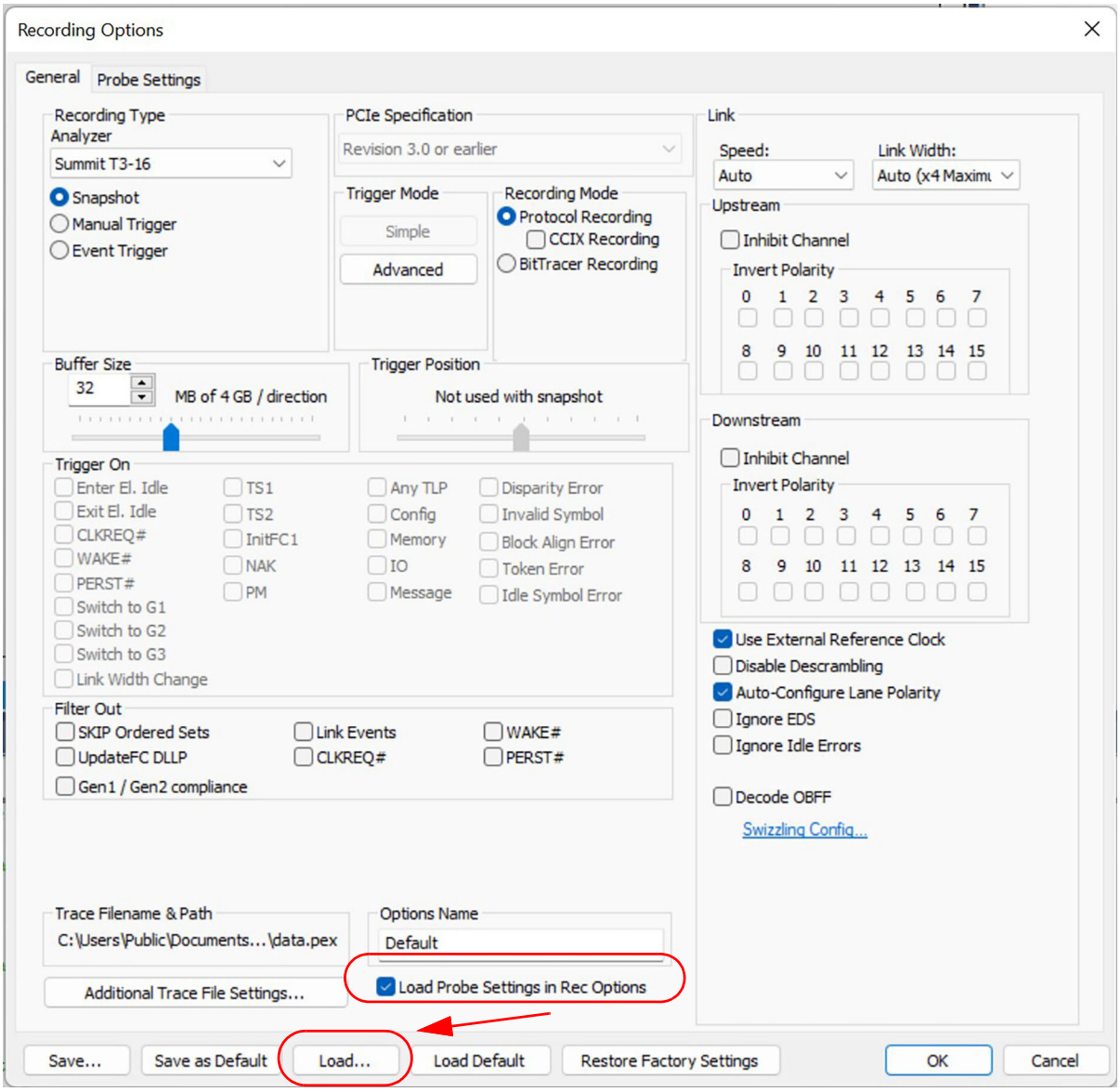


Figure 5.11: Load Probe Settings from User File

Select the file of Probe Settings you want to use and click Open. See Figure 5.12.

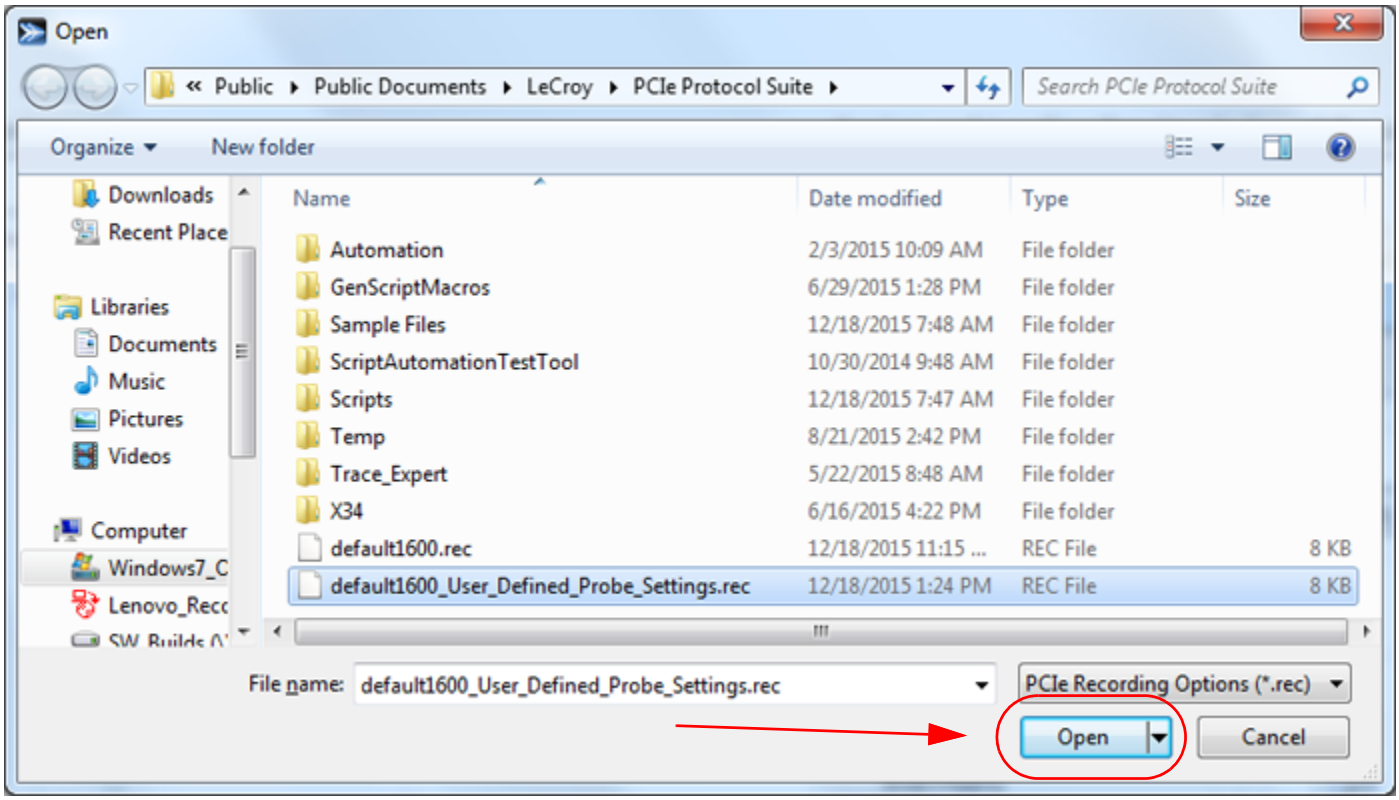


Figure 5.12: User Defined Probe Settings File

If you then select the Probe Settings tab, you'll see that the Probe Settings from the file you selected have been applied. See Figure 5.13.

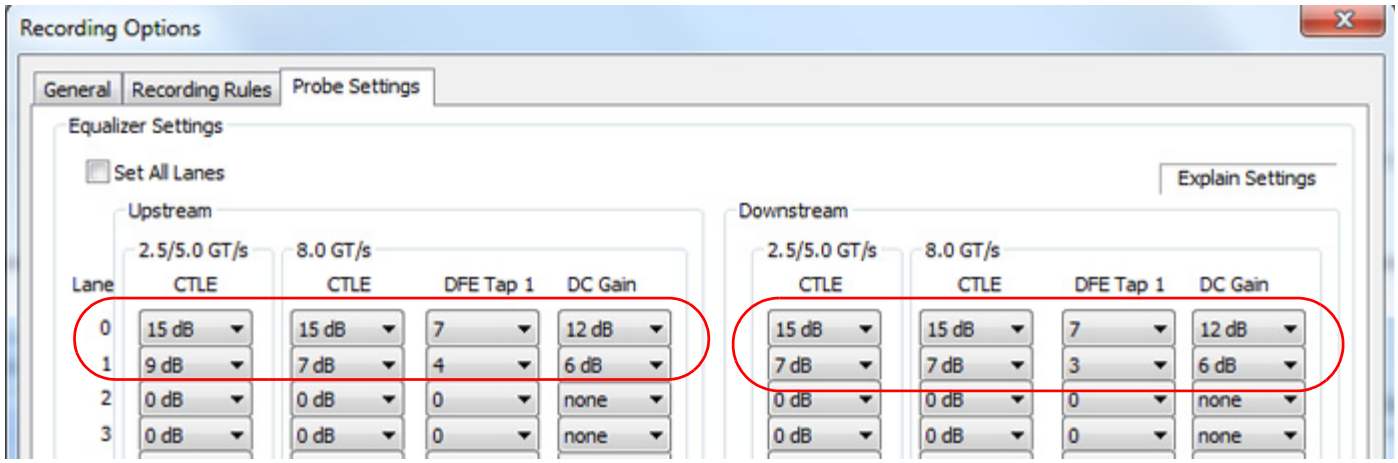


Figure 5.13: User Define Probe Settings Applied

If you load a set of Probe Settings but you've de-selected the "Load Probe Settings In Rec Options" checkbox the probe settings **will not** be applied. The "Load Probe Settings In Rec Options" checkbox on the General Options Tab must be set to apply Probe Settings.

5.5.3 Loading Recording Options

In the Recording Options menu, you can load a previously saved recording options file.

To load Recording Options:

1. Select **Setup > Recording Options** from the menu.
2. Click the **Load** button from the Recording Options dialog. The Load dialog opens and lists previously saved options files.
3. Select a file and its extension (see Figure 5.14) then click **OK**. The options file loads.

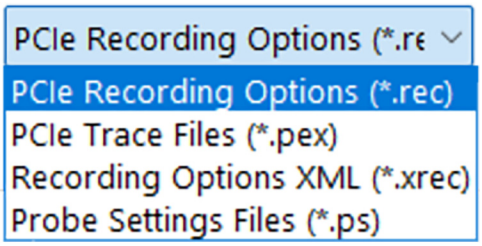


Figure 5.14: Load Extension Choices

5.5.4 Saving Recording Options

Recording Options settings can be saved and later reused. Recording options settings are stored in the following types of files:

Recording Options settings can be saved and later reused by loading previously saved files. Recording options settings are stored in files with various extensions. File options are:

- General Recording (**.rec** extension): A general recording options file which contains settings from the 'General(Tab)', 'Recording Rules' and 'Analyzer Calibration' tabs
- Recording Options in XML format (**.xrec** extension): Recording options file which contains settings from the 'General', 'Recording Rules' and 'Analyzer Calibration' tabs in XML format.
- Probe Settings (**.ps** extension): See "Probe Settings" on page 360.

To save recording options:

1. Open the Recording Options dialog by selecting **Setup > Recording Options.**
2. Set your options, then click **Save**.
3. Enter a unique file name.
4. Choose the type from **Save as Type.** SeeFigure 5.15

.

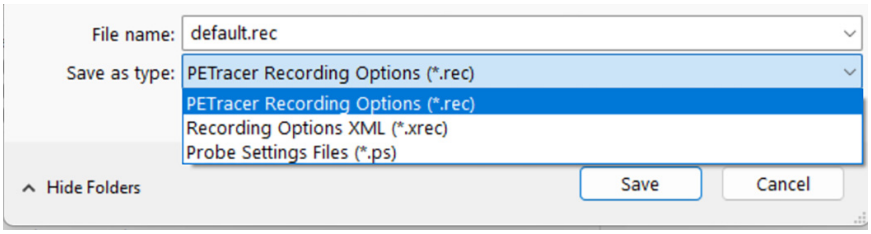


Figure 5.15: Save as Type Choices

5. (optional) To add a descriptive label to this file to help you remember what options were set, use the **Options Name** box.

5.6 Recording Type

Recording Type allows you to specify the type of recording you want to make (See Figure 5.1 on page 217: 2A). They are:

- Snapshot
- Manual Trigger
- Event Trigger

The recording options available on each analyzer are different. As shown in Figure 5.1 on page 217 the Summit T3-16 Analyzer is detected and the recording options available for it are displayed (See Figure 5.1 on page 217: 2E and Figure 5.16 on page 234).

Recording Options

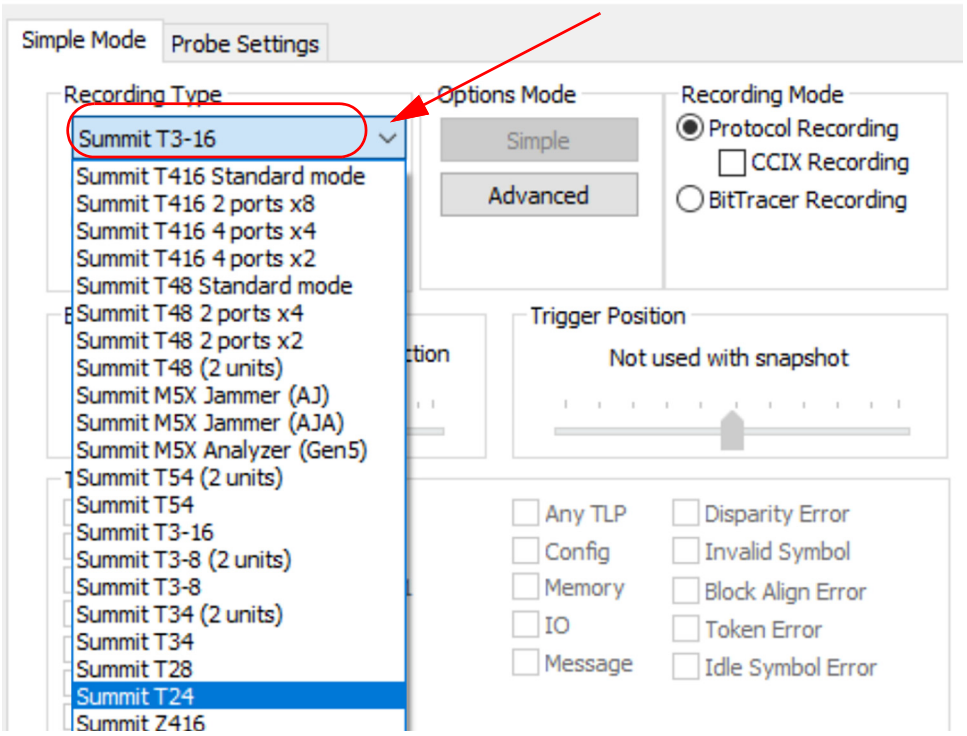


Figure 5.16: Summit T3-16 Target Analyzer Options

When the analyzer is not yet detected, you can choose the analyzer from the drop-down menu which displays the following:

- **Summit T3-16**: Displays the options for the Summit T3-16 Analyzer.
- **Summit T3-8** (2 Units): Displays the same options as Summit T3-8 but lists **Unit 1** and **Unit 2** in the Link Section on the right. In a two-unit setup, **Unit 1** and **Unit 2** are two separate Analyzers linked together.
- **Summit T3-8**: Displays the options for the Summit T3-8 Analyzer.
- **Summit T34** (2 Units): Displays the same options as Summit T34 but lists **Unit 1** and **Unit 2** in the Link Section on the right. In a two-unit setup, **Unit 1** and **Unit 2** are two separate Analyzers linked together.
- **Summit T34:** Displays the options for the Summit T34 Analyzer.
- **Summit Z416:** Displays the options for the analyzer portion of the Z416.
- **Summit T28**: Displays the options for the Summit T28 Analyzer.
- **Summit T24**: Displays the options for the Summit T24 Analyzer.

5.6.1 Snapshot

A recording of a pre-determined length. You set the recording length in the Buffer Size box. Recording begins when you click the **Rec** button on the toolbar and ends when the selected buffer size is filled or when you press the **Stop** button.

5.6.2 Manual Trigger

Recording begins when you select **Start** in the application. Pressing the **Trigger** button allows the Analyzer to finish recording by switching between the pre-trigger buffer and the post-trigger buffer. Recording continues until the post-trigger buffer has been filled. You can also end the recording immediately by pressing the **Stop** button in the application.

Note: Consider that when filtering is enabled, pressing the **Trigger** button will not necessarily cause the post-trigger buffer to fill automatically due to packets being filtered and not stored. In this case, you will have to use the **Stop** button to immediately end the recording.

5.6.3 Event Trigger

A recording that switches between the pre-trigger buffer and the post-trigger buffer when it is triggered by an event in the CATC Trace. An Event Trigger begins when you select **Start** in the application and ends when the specified triggering event occurs in the CATC Trace or you press **Stop**. If an event triggers the end of the recording, the Analyzer records a predefined amount of post-trigger data (specified by Trigger Position and Buffer Size.)

You can also terminate an Event Trigger recording by pressing the Manual Trigger button on the front of the Analyzer. When the Manual Trigger button is pressed, the Analyzer continues to record until the specified post-trigger buffer has been filled.

5.7 Buffer Size

The Buffer Size allows the Analyzer to record traffic to its buffer and then upload the CATC Trace to the host machine. Recordings are limited in size to the size of the Analyzer's buffer, see Table 5.3 on page 236. The Buffer Size slide-bar allows you to set the size of the recording buffer (see Figure 5.17).

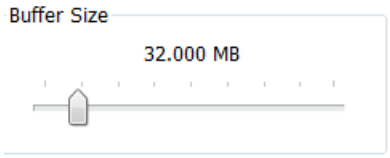


Figure 5.17: Buffer Size Slide Bar

The size selection is per direction. For example, selecting 32 MB creates two memory areas of that size.

After you have set the Buffer Size, you must set the Recording type and Trigger position options. These options determine how the buffer is used.

Each Analyzer has a different buffer size:

TABLE 5.3: Buffer Size per Analyzer

Analyzer	Default Buffer Size	Max Buffer Size
T3-16	32 MB	4 GB each Direction
T3-8	32 MB	2 GB each Direction
Two T3-8s (Expansion Mode)	32 MB	4 GB each Direction
T34	32 MB	16 GB each Direction
Two T34s (Expansion Mode)	32 MB	32 GB each Direction
T28	32 MB	2 GB each Direction
T24	32 MB	1 GB each Direction

Note: The Buffer Size slide-bar does not precisely portray the buffer size because of the way the packets are stored in the Analyzer's memory.

5.8 Recording Modes

5.8.1 Recording Modes: T3-16, T38, T28, T24

There are two options for Recording Mode for all Summit Analyzers except the T34:

- Protocol Recording
  - CCIX Recording
- Bit Tracer Recording

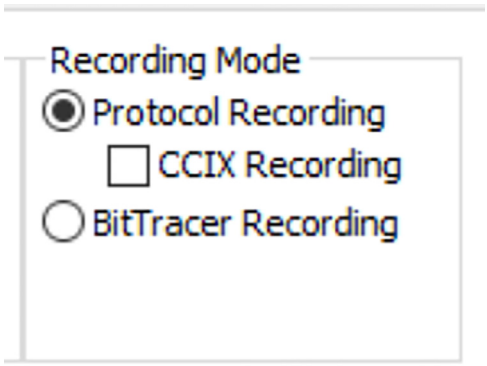


Figure 5.18: Typical Recording Mode Options

5.8.2 Recording Modes: T34

The Summit T34 also has an NVMe Enhanced Recording Mode and SMBus Recording Mode.

There are three primary options for Recording Mode with the T34:

- Protocol Recording
  - SMBus Recording
- Bit Tracer Recording
- NVMe Enhanced Mode

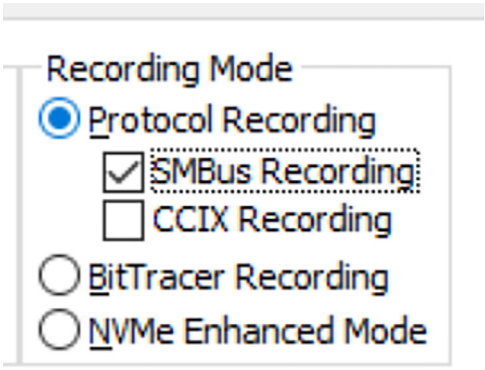


Figure 5.19: T34 Recording Mode Options

5.8.3 Protocol Recording

The Protocol Recording mode is an intelligent mode that understands the protocol and

displays the recorded data according to the specification. By default it uses the CATC Trace View to show the traffic happening on the wire.

You can use most of the triggering, filtering and sequencing features.

5.8.3.1 SMBus Recording

When this mode is also selected both Data traffic and SMBus traffic will be recorded.

For an example of SMBus traffic see “Decoding MCTP Messages with SMBus Traffic” on page 467.

5.8.3.2 Recording the CCIX Protocol

PCIe Protocol Analysis software can record the Cache Coherent Interconnect for Accelerators (CCIX) transaction protocol.

CCIX is a high-performance, low latency, chip-to-chip interconnect architecture that provides a cache coherent framework for heterogeneous system architectures. Cache coherency is automatically maintained at all time between the central processing unit and the various other accelerators in the system. Operating over standard PCIe, CCIX supports signaling rates between 16 GT/s and 25 GT/s per link with support for port aggregation for higher performance.

CCIX is largely an extension of the PCI Express architecture, consists of a number of stacked protocol layers.

- CCIX Protocol Layer - coherency protocol that manages memory reads and writes, provides a mapping for the on-chip architecture-dependent coherency protocols (e.g., AMBA CHI/ACE). This layer also defines the cache state (e.g. shared/unique, clean/dirty).
- CCIX Link Layer - formatting protocol for transport (e.g., PCIe). This layer also manages link aggregation.
- CCIX Transport Specification
- PCIe Transaction Layer - Handles PCIe transactions. The layer also supports virtual channels, permitting transmission for different data streams across a single shared link.
- CCIX Transaction Layer - Handles CCIX transactions. This layer optimizes out superfluous PCIe packet fields, reducing overhead.
- PCIe Data Link Layer - Handles standard data link layer (e.g., CRC, ACK).
- CCIX/PCIe Physical Layer - Handles standard PCIe physical layer. This layer also supports 25 GT/s ESM mode.

CCIX decoding relies on Traffic Class (TC) to Virtual Channel (VC) mapping to be configured. If not configured you’ll get the warning message below. See Figure 5.20 on page 239.

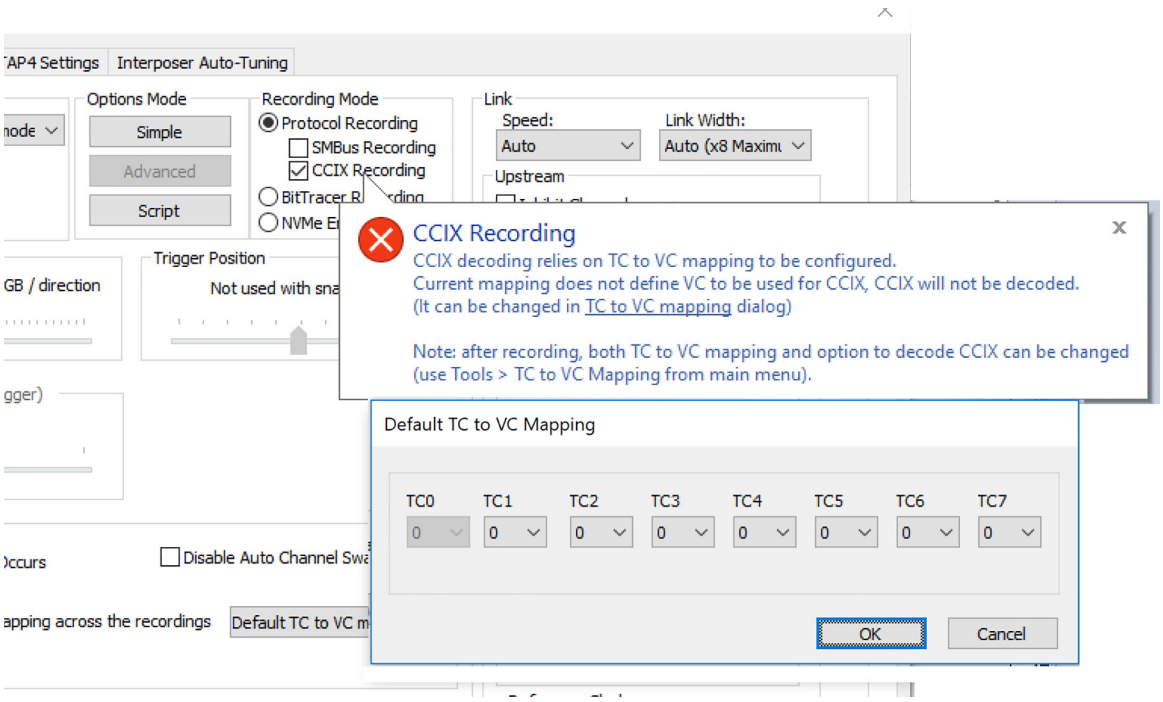


Figure 5.20: Selecting CCIX Recording Before Mapping from TC to VC

After mapping TC to VC the warning message goes away, as shown in Figure 5.21

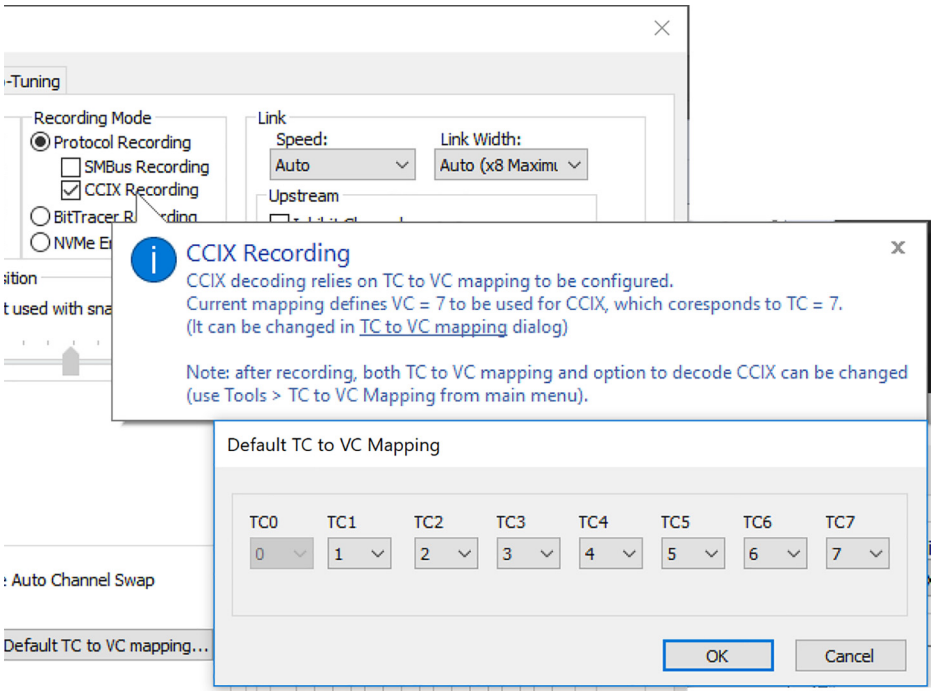


Figure 5.21: Selecting CCIX Recording After Mapping from TC to VC

See "Decoding CCIX Protocol" on page 502 for more details.

5.8.4 Bit Tracer Recording

When the Bit Tracer Recording box is checked, the recording behaves as a regular serial logic analyzer. The data is displayed in Bit Tracer view which displays the symbols being transmitted on each PCI Express lane. In this mode, you can trigger on the same events and use the sequencer as with Protocol Recording Mode but filtering is not allowed. The Bit Tracer mode will record all the traffic.

The option "Lane Deskew Bypass" is provided as a debug feature and limits the triggers to be used to only the basic resources and Packet Match using ordered sets. You can still use triggering for DLLPs and TLPs but since the data is not deskewed, it will trigger on a pattern that matches your selection but may not necessarily be a valid packet. See Figure 5.22 on page 240.

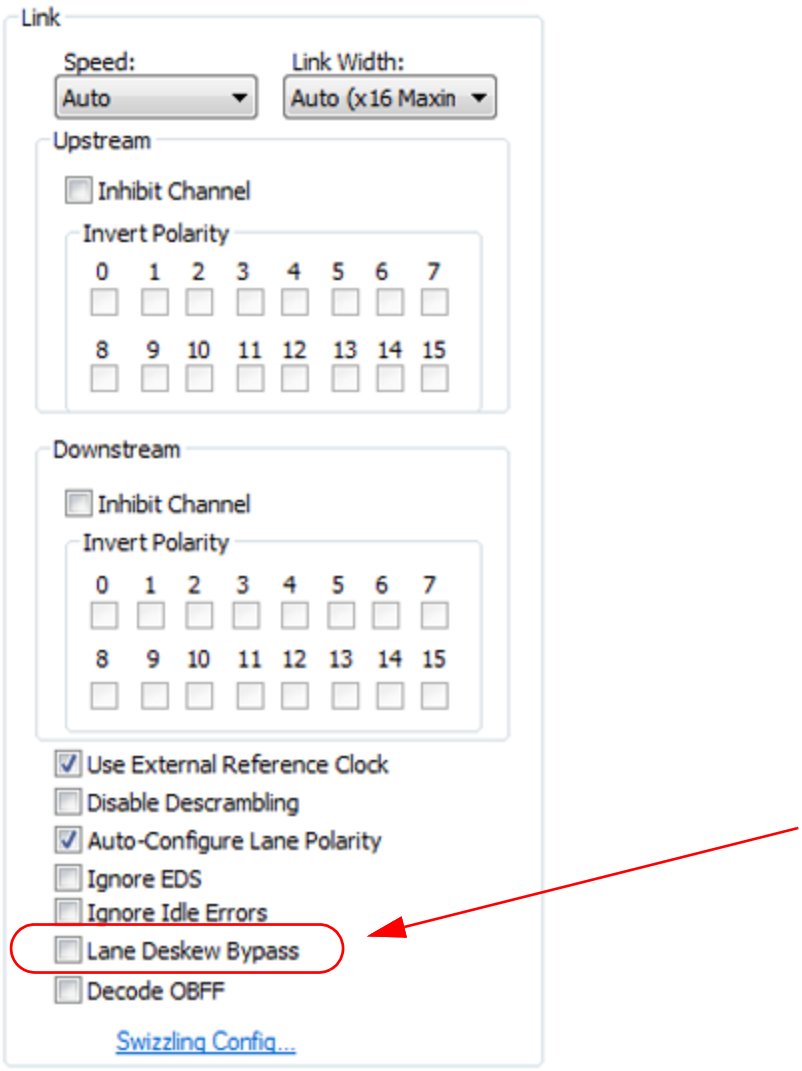


Figure 5.22: Bit Tracer Recording: Lane Deskew Bypass Mode

Note: Leaving all the boxes unchecked results in no trigger in that direction. For more information, see "BitTracer Recording" on page 593.

5.8.5 NVMe Enhanced Recording

When this mode is selected and Simple Mode is used, the GUI will be configured optimally to allow recording of very long captures of PCIe traffic that will be decoded as NVMe.

Before using this mode, make sure all the PCIe Link parameters are selected properly. You can achieve this by recording a trace in Protocol Recording mode during L0 and confirm the trace looks clean. Once you have found the correct Link parameters they will be used in NVMe Enhanced Recording mode.

For more details see "NVMe Enhanced Recording Mode: Summit T34 Only" on page 369.

5.9 Trigger Position

This Trigger Position slide-bar lets you adjust the amount of recording buffer allocated to recording pre-trigger and post-trigger traffic (See Figure 5.1 on page 217: 2F).

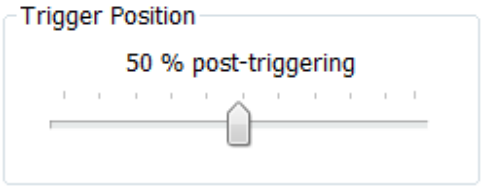


Figure 5.23: Trigger Position Slide Bar

For example, if you set the Trigger Position to 90% Post-Triggering Traffic, the Analyzer records 10% pre-trigger traffic and 90% post-trigger traffic.

Trigger Position is only available when Manual Trigger or Event Trigger is selected.

5.10 Viewing Legacy Multi-Segmented CATC Traces

Current PCIe Protocol Analysis handles traces as large as the maximum buffer size selected. It does not need to generate segmented traces, but is able to open segmented traces generated with older software versions. Simply open the *.pem extension file and the trace will be converted to a new format single trace. If opening a *.pex file part of a segmented trace make sure not to update the file in order for the original segmented index to work properly.

5.11 Link Settings

The Link options panel allows you to manage links (see Figure 5.24). You can define the basic link parameters or leave it on Auto detect. The various link settings are described in this section (See Figure 5.1 on page 217: 3).

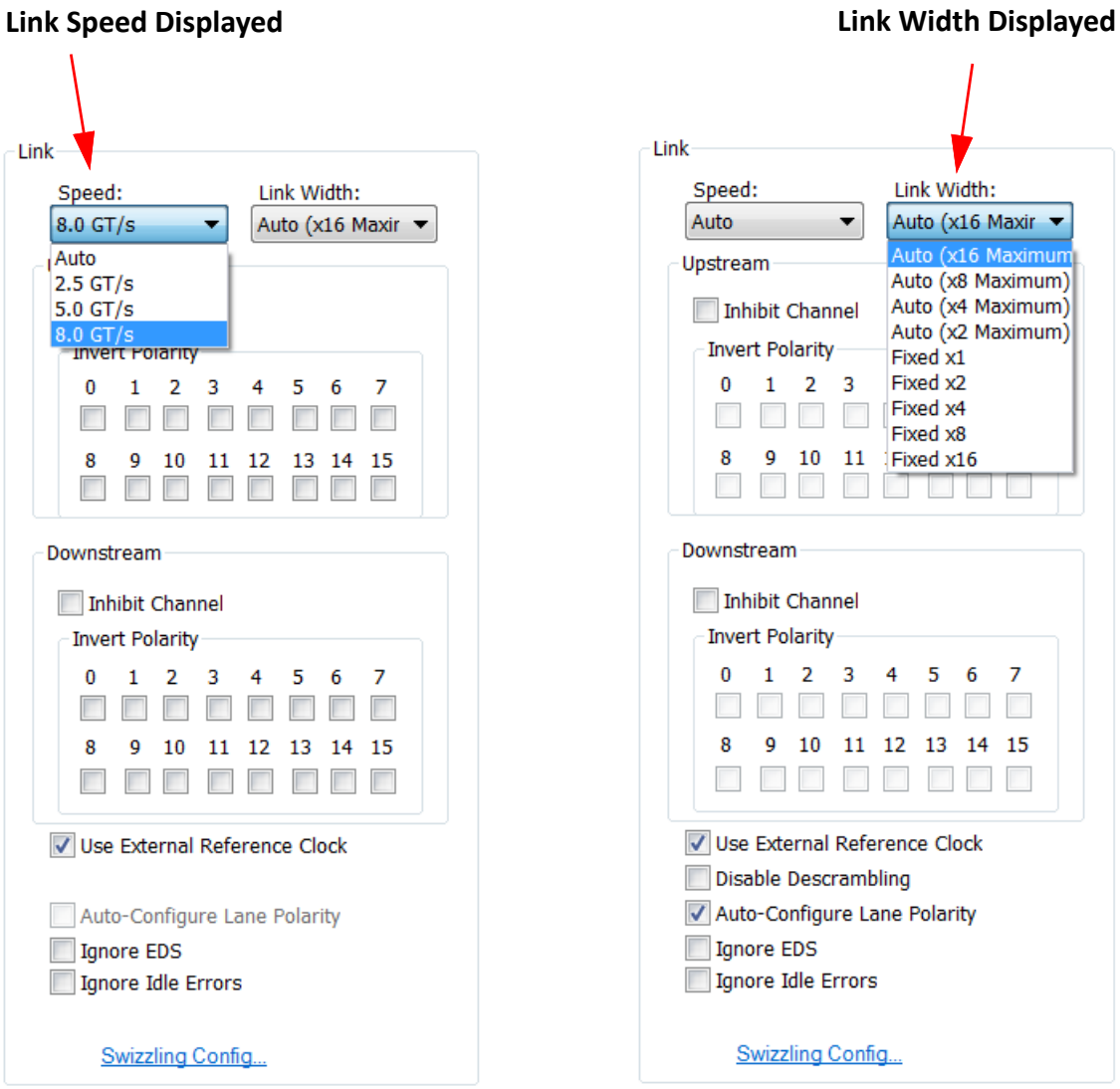


Figure 5.24: Link Options for Summit T3-16

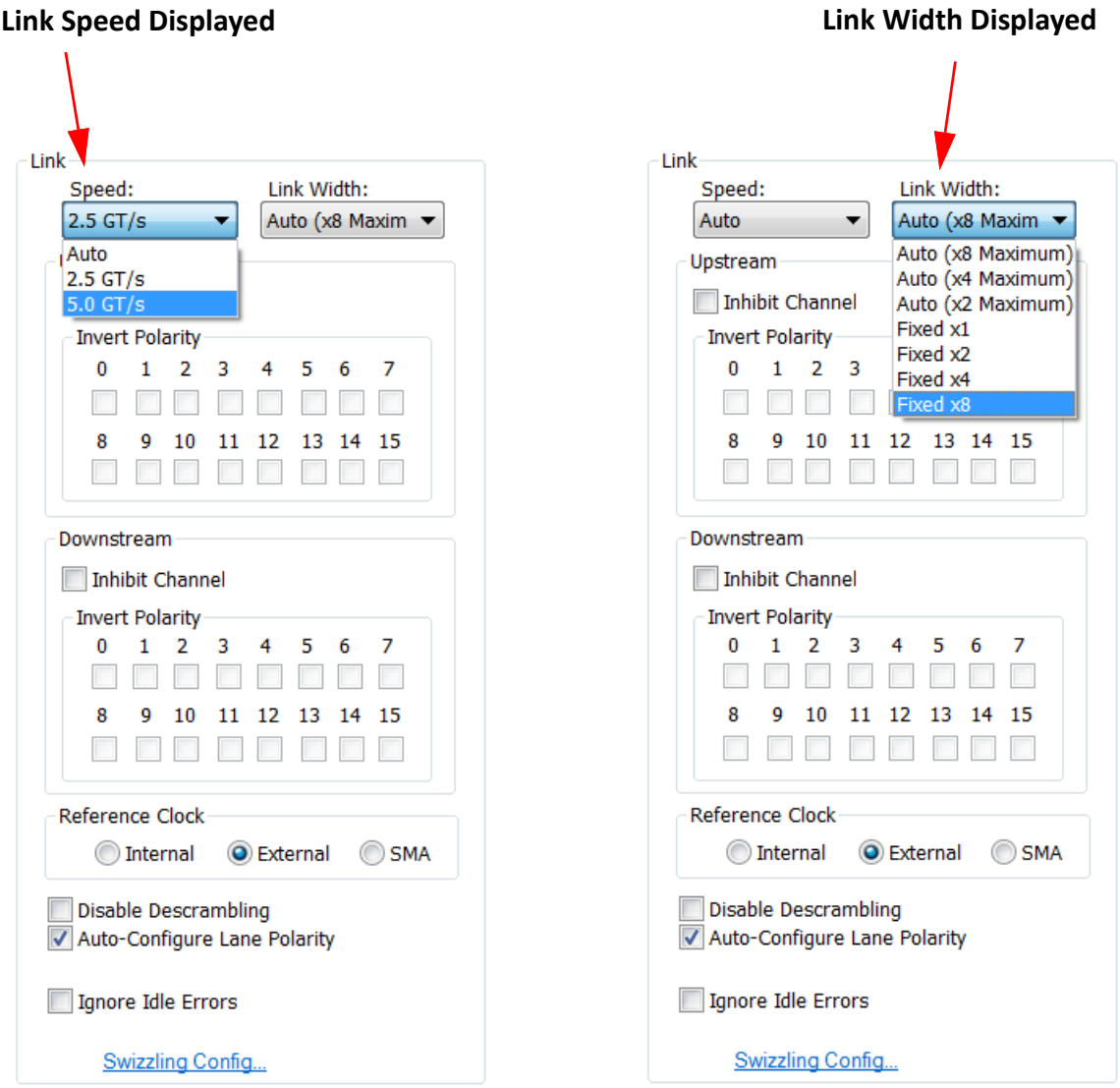


Figure 5.25: Link Options for Summit T28

5.11.1 Speed

5.11.1.1 Gen3 Analyzers

Depending on unit capabilities or licensing, the Speed for the PCIe Summit Gen3 Analyzers (T3-16, T3-8 and T34) is 8.0 GT/s, 5.0 GT/s, or 2.5 GT/s.

The Speed can be set at Auto, 8.0 GT/s, 5.0 GT/s, or 2.5 GT/s from the drop-down menu. The default is Auto (see Figure 5.1 on page 217: 3A or Figure 5.24 on page 244 left side).

Auto: When set to Auto, Teledyne LeCroy's embedded software auto-determines the speed.

8.0 GT/s, 5.0 GT/s, or 2.5 GT/s: When set to a specific speed Teledyne LeCroy's software forces the hardware to record at that speed.

For Auto speed setting to work the polarity setting of lane 0 has to be correct. The polarity can be set manually if the link is already in L0 state, or, for automatic polarity

detection, the bus has to go through a training sequence so the analyzer can track the polarity.

Note: For certain build configurations speed options 5.0 GT/s and 8.0 GT/s may be disabled.

Note: When selecting Auto in the Speed drop-down list the embedded software is able to find the correct speed even if the link does not go through a training sequence.

5.11.1.2 Gen2 Analyzers

Depending on unit capabilities or licensing, the Speed for the PCIe Summit Gen2 Analyzers (T28 and T24) is 5.0 GT/s, or 2.5 GT/s.

The Speed can be set at Auto, 5.0 GT/s, or 2.5 GT/s from the drop-down menu. The default is Auto (see Figure 5.1 on page 217: 3A or Figure 5.25 on page 245 left side).

Auto: When set to Auto, the hardware auto-determines the speed.

5.0 GT/s or 2.5 GT/s: When set to a specific speed, Teledyne LeCroy's software forces the hardware to record at that speed.

For Auto speed setting to work the polarity setting of lane 0 has to be correct. The polarity can be set manually if the link is already in L0 state, or, for automatic polarity detection, the bus has to go through a reset so the analyzer can track the polarity.

Note: For certain build configurations speed option 5.0 GT/s may be disabled.

Selecting Auto in the Speed drop-down list will set the correct speed even if the analyzer does not record a link training sequence.

5.11.2 Link Width

Each Analyzer has a different link width:

TABLE 5.4: Link Width per Analyzer

Analyzer	Max Link Width
T3-16	16
T3-8	8
Two T3-8s (Expansion Mode)	16
T34	4
Two T34s (Expansion Mode)	8
T28	8
T24	4

The Link Width sets the physical width of the link. Select the Link Width from the drop-down menu (see Figure 5.1 on page 217: 3B or Figure 5.24 on page 244 right side). The

available options (and the default) will be shown according to the detected product. The list below reflects the capabilities of the Summit T3-16.

Auto Max X16Calculates link width automatically up X16

Auto Max X8 Calculates link width automatically up X8

Auto Max X4 Calculates link width automatically up X4

Auto Max X2 Calculates link width automatically up X2

Fixed X1 Link is assumed to be always X1

Fixed X2 Link is assumed to be always X2

Fixed X4 Link is assumed to be always X4

Fixed X8 Link is assumed to be always X8

Fixed X16 Link is assumed to be always X16

Note the following:

- If the bus goes to a link width different from the one selected as fixed option, the trace will be full of errors. The appropriate Auto option needs to be selected in this case.
- When selecting Auto in the Link Width drop-down list the embedded software is able to find the correct link width even if the link does not go through a training sequence.
- If an Auto Link Width is selected, there is no Lane Reversal. If a Fixed Link Width is selected, the Reverse Lanes checkbox is enabled. See Figure 5.26 on page 248 for the T316. Other Summit T3 and T2 analyzers have the same behavior.

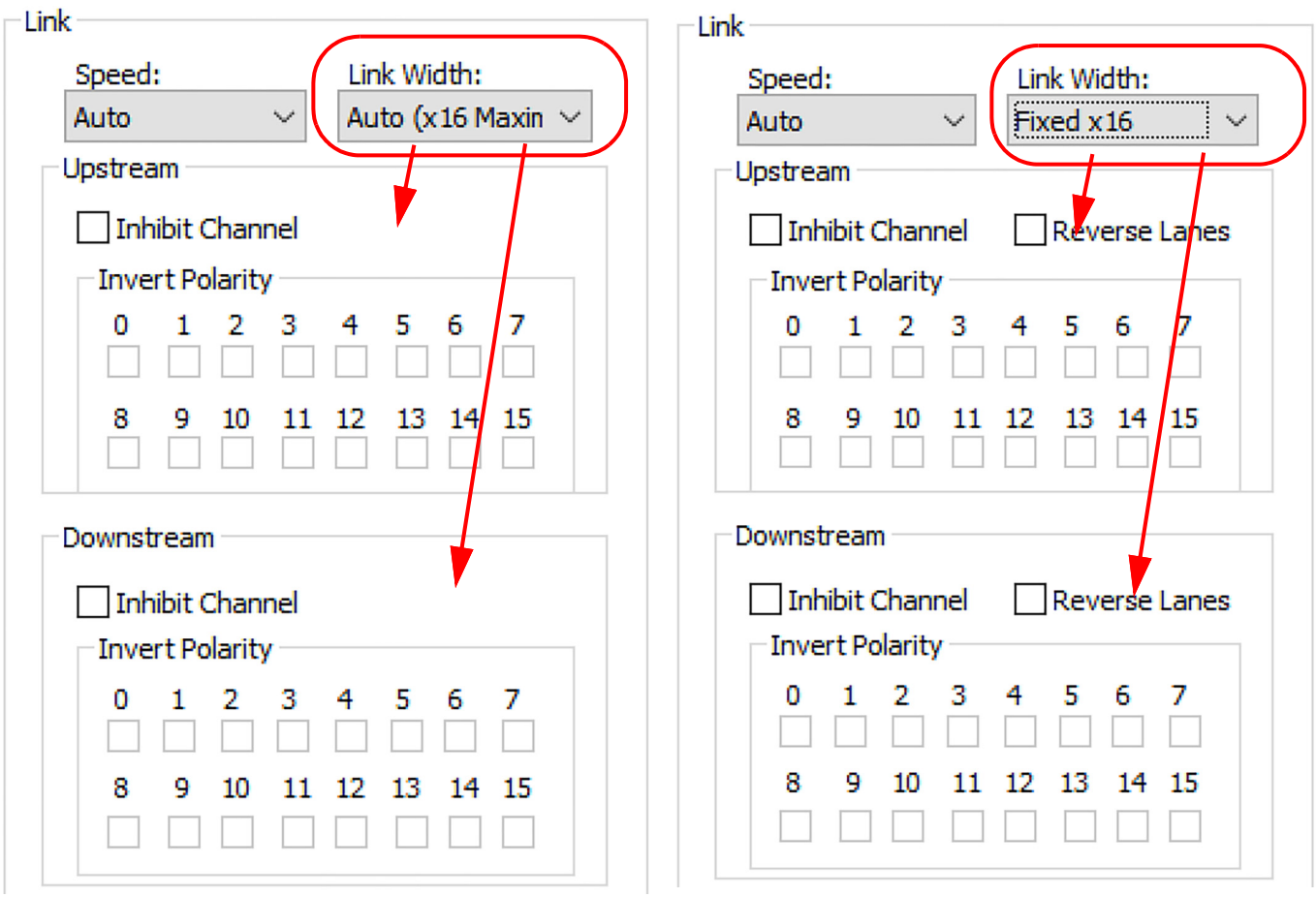


Figure 5.26: T316 Link Width: Auto -> No Lane Reversal,
Fixed Lane Width -> Lane Reversal Check Box is Enabled

5.11.3 Upstream and Downstream

Gives you low-level control over each link direction. The heading for these boxes indicates the port and/or unit to which the following options are applied based on the current Analyzer configuration (see Figure 5.1 on page 217: 3C and 3D).

- Inhibit Channel: Do not record/upload this channel
- Reverse Lanes: Manual lane reversal. If Auto-Configure Lane Swizzle is set, the Reverse Lanes option will be ignored.
- Invert Polarity

5.11.4 Reference Clock Options

Note: Due to long exit latency from low power sub states some loss of traffic has been observed when analyzer latency exceeds DUT latency using the common reference clock. Teledyne recommends the use of the internal reference clock setting for low power sub-states testing.

The Summit T3-16 and T3-8 Analyzers have the same Reference Clock Options (see "Use External Reference Clock: T3-16 and T3-8" on page 250).

The Summit T34 and T28 Analyzers have slightly different options for implementing a reference clock (see "Use Reference Clock: T34 and T28" on page 250).

The Summit T24 has its own reference clock scheme (see "Use Reference Clock: T24" on page 251).

5.11.4.1 Use External Reference Clock: T3-16 and T3-8

(see Figure 5.1 on page 217: 3E)

Internal

The analyzer has an internal clock generator that can be used for recording when the Device Under Test does not supply a reference clock. In this case, you de-select the External Reference Clock checkbox.

Note: If the PCI Express link under analysis uses spread-spectrum clocking, then the Analyzer must use an external reference clock from the system. Select the External Reference Clock checkbox.

External

For the T3-16/T3-8, External Clock means to use the clock that is supplied through the Y iPass cable. You also need to select the External Reference Clock checkbox. The iPass cable gets its clock from the specific interposer being used with the analyzer, which in turn may have up to two different clock sources: RefClk from the PCIe edge connector (all interposers have this option) or the SMA connectors.

Teledyne LeCroy's latest interposers (Gen3) usually support separate clocks for SRIS applications.

5.11.4.2 Use Reference Clock: T34 and T28

(See Figure 5.2 on page 218: 3M and Figure 5.3 on page 219: 3M.)

Internal

The analyzer has an internal clock generator that can be used for recording when the Device Under Test does not supply a reference clock. In this case, you select the Internal Reference Clock checkbox.

Note: If the PCI Express link under analysis uses spread-spectrum clocking, then the Analyzer must use an external reference clock from the system. Select either the External or the SMA option.

External

For the T34/T28, External clock means to use the clock that is supplied through the straight iPass cable. You also need to select the External Reference Clock checkbox. The straight iPass cable gets its clock from the specific interposer being used with the analyzer, which in turn may have up to two different clock sources: RefClk from the PCIe edge connector (all interposers have this option) or the SMA connectors.

The straight iPass cable connected to the T34/T28 supplies a single clock so the only way to support SRIS applications is to provide separate clocks to the front panel SMAs.

When using two T34 in Expansion Mode, the external clock option (using the clock from the Y iPass cable) will provide SRIS functionality when using an interposer with this capability so there is no need to use the SMAs from the front panel.

SMA

The SMA clock recording option refers to the **Ref Clk In** SMA input connectors on the front panel of the analyzer. This recording option in the user interface controls both Upstream and Downstream clock selection. When using the SMA option both clock cables must be connected and the clock must be supplied by the system in order for the recording to happen correctly. The standard PCI Express compliant reference clock is supported. You also need to select the SMA Reference Clock checkbox.

For the T34/T28, SMA means to use the clock supplied at the SMA connector from the T34/T28 unit's front panel.

5.11.4.3 Use Reference Clock: T24

(See Figure 5.3 on page 219: 3M – But Internal or External only)

Internal

The analyzer has an internal clock generator that can be used for recording when the Device Under Test does not supply a reference clock. In this case, you select the Internal Reference Clock checkbox.

Note: If the PCI Express link under analysis uses spread-spectrum clocking, then the Analyzer must use an external reference clock from the system. Select the External Reference Clock checkbox.

External

For the T24, External Clock means to use the clock that is supplied through the straight iPass cable. In this case, you select the External Reference Clock checkbox.

The iPass cable gets its clock from the specific interposer being used with the analyzer, which in turn may have up to two different clock sources: RefClk from the PCIe edge connector (all interposers have this option) or the SMA connectors.

The straight iPass cable connected to the T24 supplies a single clock, so SRIS applications are not possible.

5.11.5 Disable Descrambling

If checked, causes the Analyzer to assume that none of the PCI Express traffic is scrambled. By default, the Analyzer determines the scrambling state of the devices under test (see Figure 5.1 on page 217: 3F).

Note: When selecting Gen3 speed the disable scrambling option is not available. This option can be used only for Gen1 or Gen2 speeds. It will show as well for Auto speed but it affects only Gen1 or Gen2 traffic.

5.11.6 Auto-Configure Lane Polarity

Lets the Analyzer determine lane polarity (see Figure 5.1 on page 217: 3G). Auto functions such as Auto Configure polarity rely on Gen1 or Gen2 training sequences to properly discover their values. If the speed option is set to fixed Gen3, the analyzer will never see these sequences and the polarity discovery will not be reported properly in the dashboard dialog.

5.11.7 Ignore EDS

Lets the Analyzer ignore End of Stream (EDS) token. (See Figure 5.1 on page 217: 3H.)

5.11.8 Ignore Idle Errors

When set analyzer will not store errors in between packets into memory. This option helps to preserve analyzer memory to store more packets in cases where memory efficiency is critical. This option filters out Compliance Pattern as well. (see Figure 5.1 on page 217: 3I.)

5.11.9 Decode Optimized Buffer Flush/Fill (OBFF)

Select this checkbox to decode Optimized Buffer Flush/Fill (OBFF) events. See Figure 5.1 on page 217: 3J). As a system operates, each of its devices does not know the power state of each of the resources in the system. Without coordination, each of the devices will go in and out of their low-power states as necessary to execute the tasks they are assigned to do. This "asynchronous" behavior prevents the optimal power management of the CPU, host memory sub-system and other devices, because the intermittent traffic keeps the system permanently awake and unable to optimize power management across the system.

As part of an implementation of a system-level power strategy, the idle time and low-power states of the devices must be optimized to enable them to stay in their low-power states longer. Basically, a host can provide information to all devices by broadcasting a message about the system power state. The devices can utilize this information to group a load of requests, wait until the system wakes up, and burst out all of the requests at the same time. By doing this, the device does not wake up a sleeping CPU and/or the system memory sub-system. Waiting creates extended periods of system inactivity which saves overall system power. The host utilizes the OBFF to give devices a "hint" so they can optimize their behavior, which improves power management at the system level.

5.11.10 Swizzling Config...

The Swizzling Config dialog allows you to reconfigure the logical order of the lanes in a link separately for Upstream and Downstream PCIe directions. You can perform the logical to physical assignment manually or let the analyzer detect this on its own (Auto-Configure Lane Swizzle option checked). (see Figure 5.1 on page 217: 3K and Figure 5.27 on page 255).

Note: Autoswizzle works only when the analyzer sees the LTSSM Configuration state link training sequence.

5.11.10.1 Manual Configure Lane Swizzle

If you know how your physical link is connected and the lane numbers advertised for each lane, then you can use the manual swizzle option (Auto-Configure Lane Swizzle option unchecked). On the Swizzling Configuration dialog, drag the number of the logical lane (in blue) to the desired lane physical position.

In the case shown below the Link Width is set to Auto (x16 Maximum), so all 16 lanes are available to be manually configured. See Figure 5.27 on page 255.

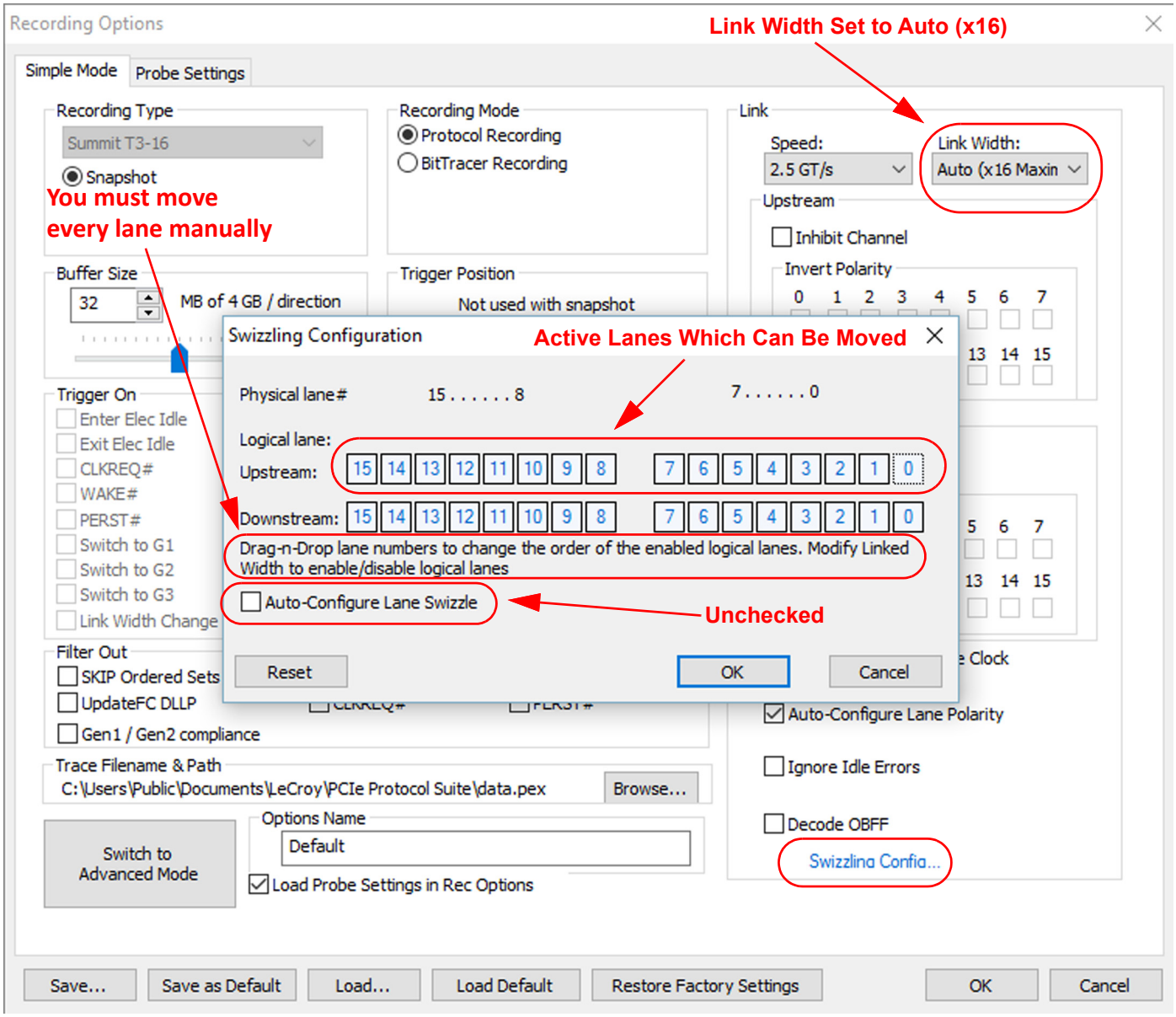


Figure 5.27: Manual Swizzle: Link Width Set to Auto (x16)

In the example shown below, we re-assigned the Upstream Physical lanes as follows:

- Lane 7 to Lane 15
- Lane 6 to Lane 14
- Lane 5 to Lane 13
- Lane 4 to Lane 12
- Lane 3 to Lane 11
- Lane 2 to Lane 10
- Lane 1 to Lane 9
- Lane 0 to Lane 8

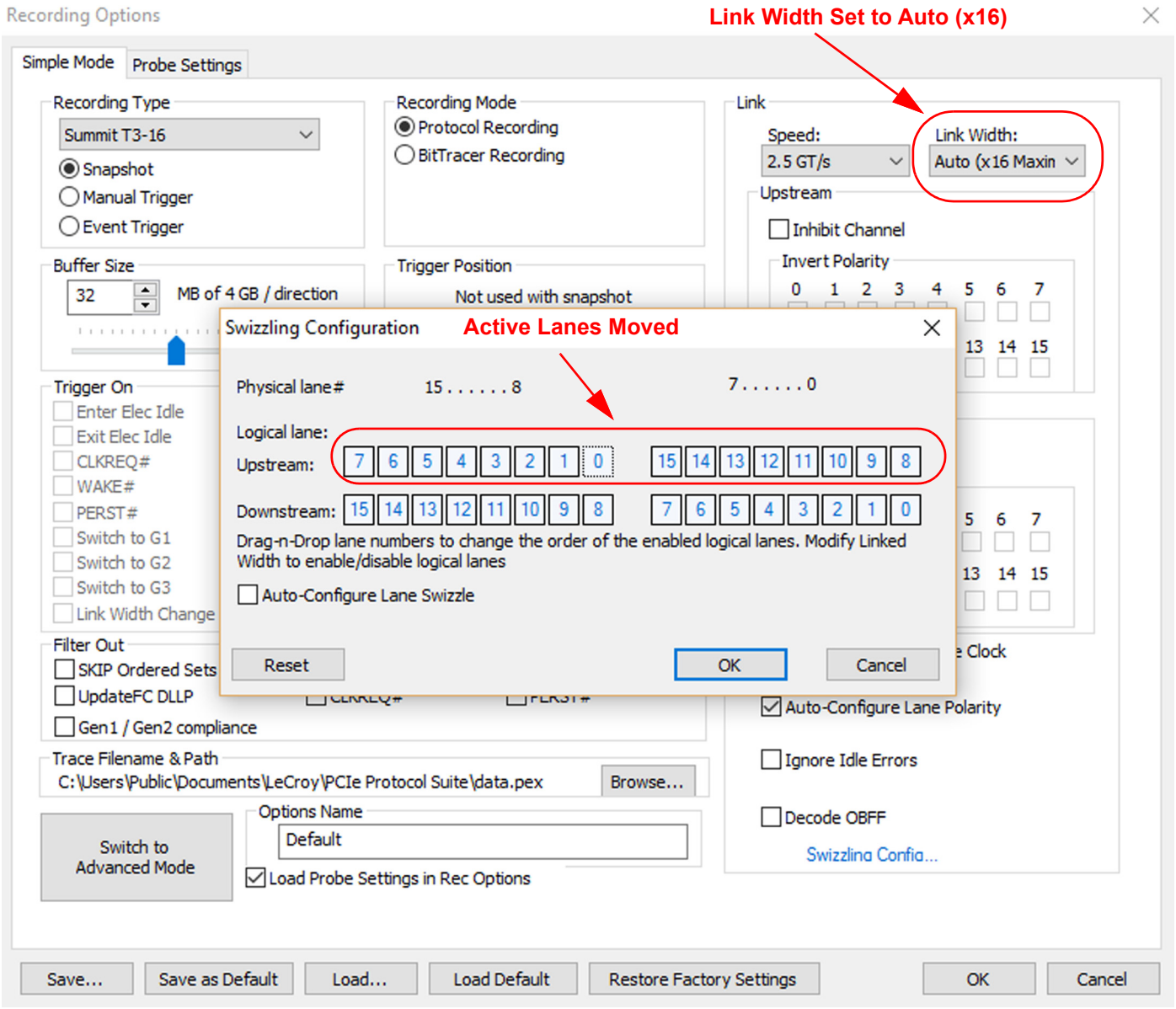


Figure 5.28: Manual Swizzle Configuration

Note: The simplest way to make new lane assignments is to always move the highest source lane number to the highest destination lane number.

Note: If the source lane has a lower number than the lane it is replacing, then the software performs a right shift to the higher numbered replaced lane. If the source lane has a higher number than the lane it is replacing the software performs a left shift to the lower numbered replaced lane.

5.11.10.2 Example: Move Highest Source Lane First

In the example below we replaced Lane 7 with Lane 3 and Lanes 7 through 4 were shifted to the right. Then Lane 7 was replaced with Lane 2 and Lanes 7 through 4 were shifted to the right. Then Lane 7 was replaced with Lane 1 and Lanes 7 through 4 were shifted to the right. Finally Lane 7 was replaced with Lane 0 and Lanes 7 through 4 were shifted to the right.

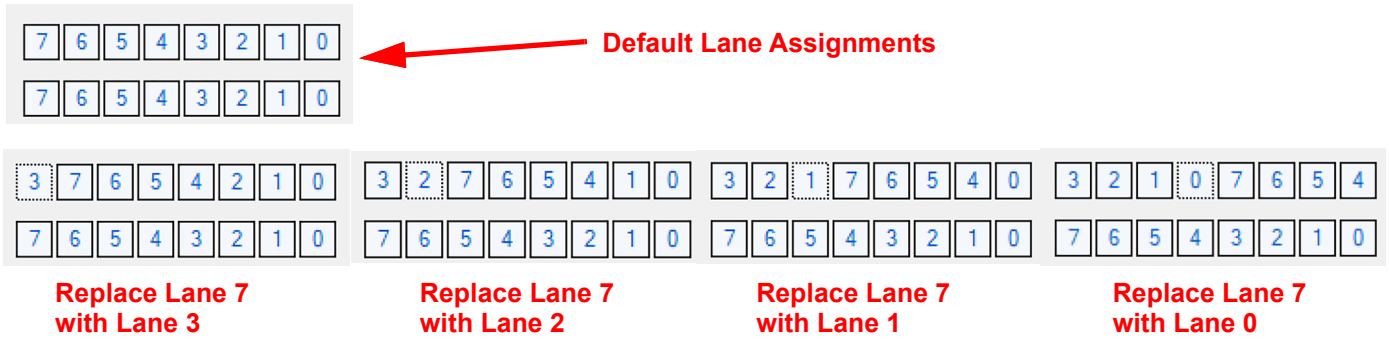


Figure 5.29: Manually Moving Lane Assignments: Highest Numbered Lane First

5.11.10.3 Example: Move Lowest Source Lane First

If you start with the lowest numbered lane you will get completely different results.

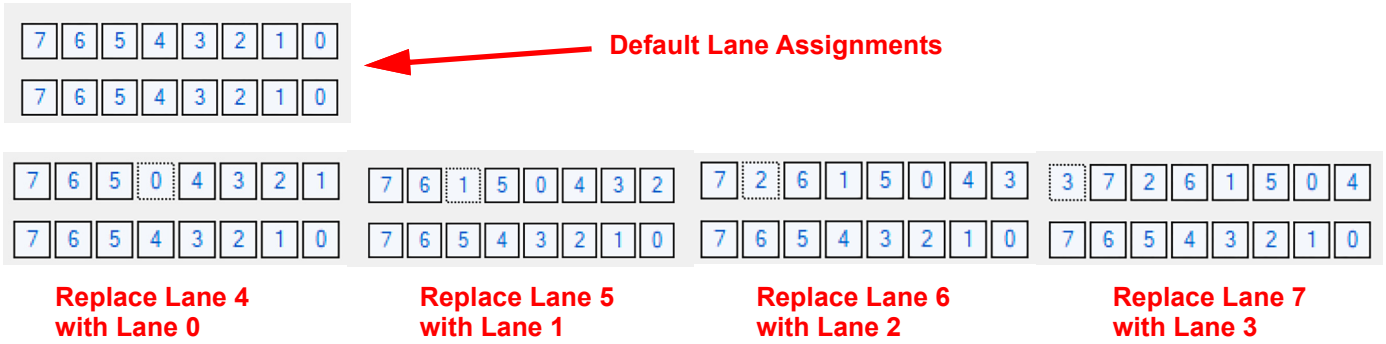


Figure 5.30: Manually Moving Lane Assignments: Lowest Numbered Lane First

5.11.10.4 Working with Less Than Sixteen Lanes

If the lane number in the box is not in blue this means that the lane is not participating in the link from the Summit analyzer's point of view. This may happen because the Link Width selected is less than x16. See Figure 5.31.

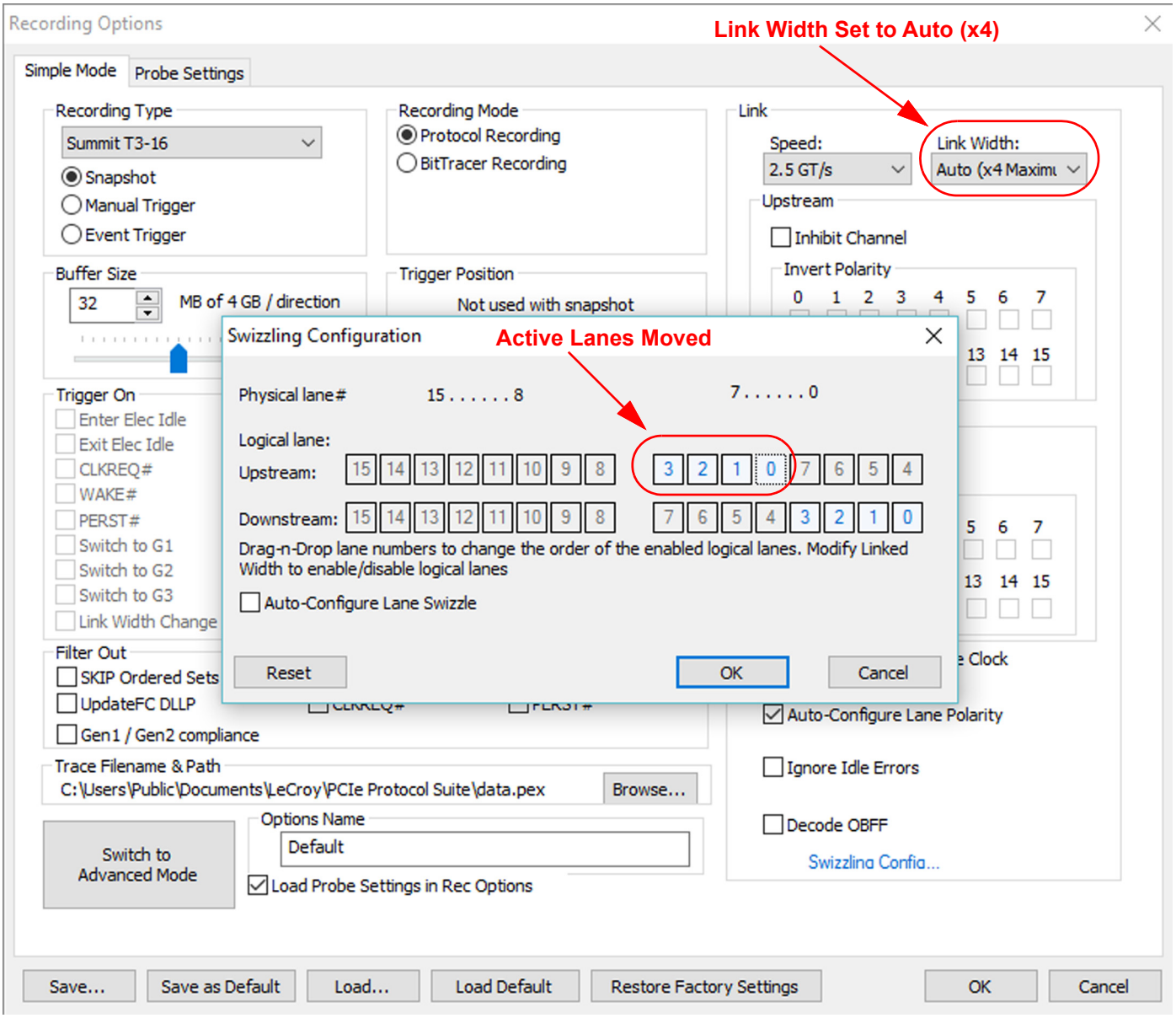


Figure 5.31: Manual Lane Swizzle Configuration: Moving Four Lanes

Note: In the example above Lane 0 through Lane 3 are the only active lanes. They can be moved to any lane that the analyzer supports. The analyzer in this case is the Summit T3-16, which can support 16 lanes.

If you need the logical lane to be assigned to a position that has a number in gray color, you need to make sure the Link Width can support that lane by increasing the Link Width option. In the case shown below, we wanted to move Lane 7 to Lane 15. To make Lane 7 an active lane we had to increase the Link Width to x8. See Figure 5.32 on page 259

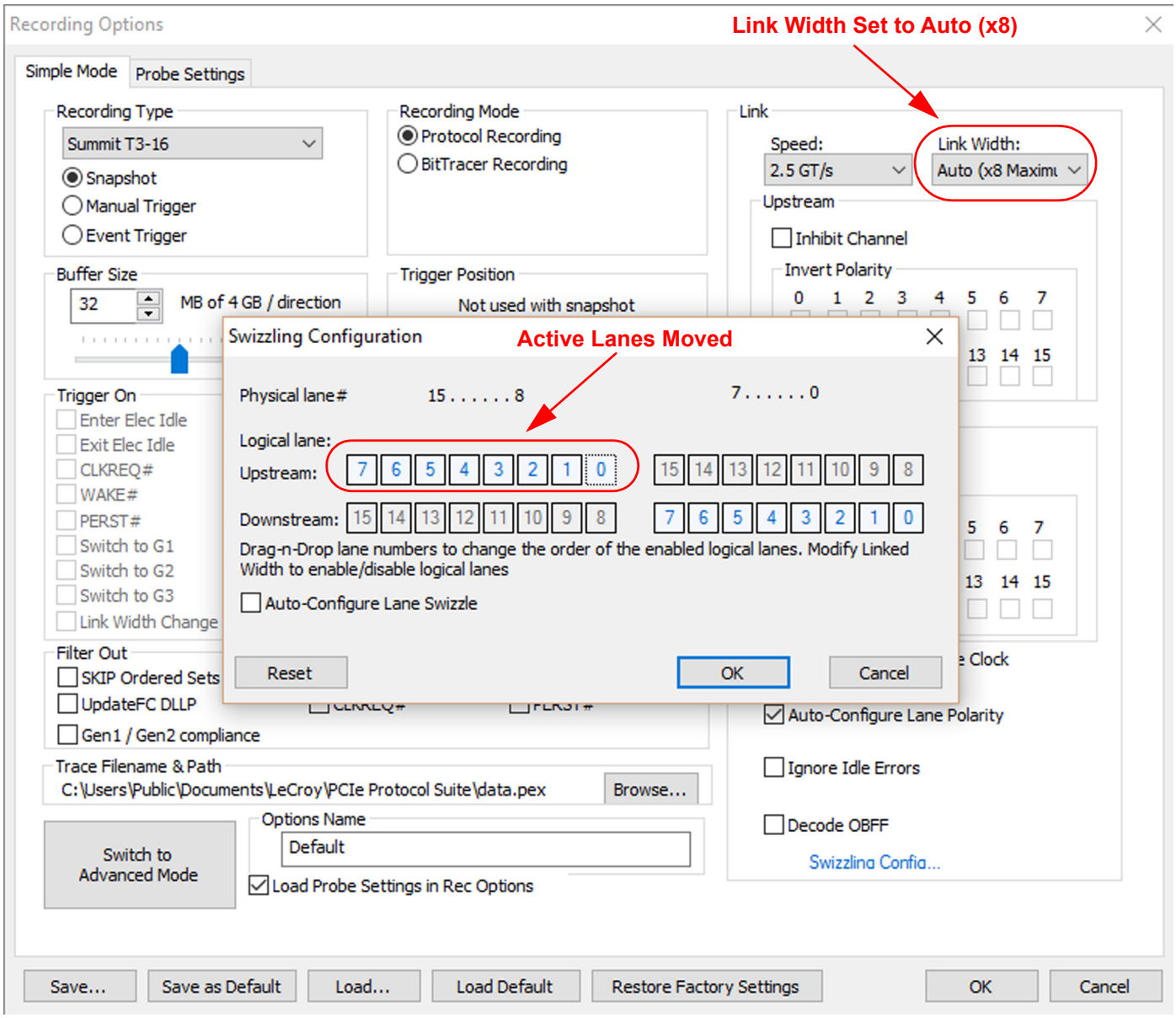


Figure 5.32: Manual Lane Swizzle Configuration: Moving Eight Lanes

Note: If the link you are trying to analyze is lower than x16 and the lane resides in a grayed position you need to select the Auto Link Width option that will include the physical lane to use.

5.11.10.5 Auto-Configure Lane Swizzle

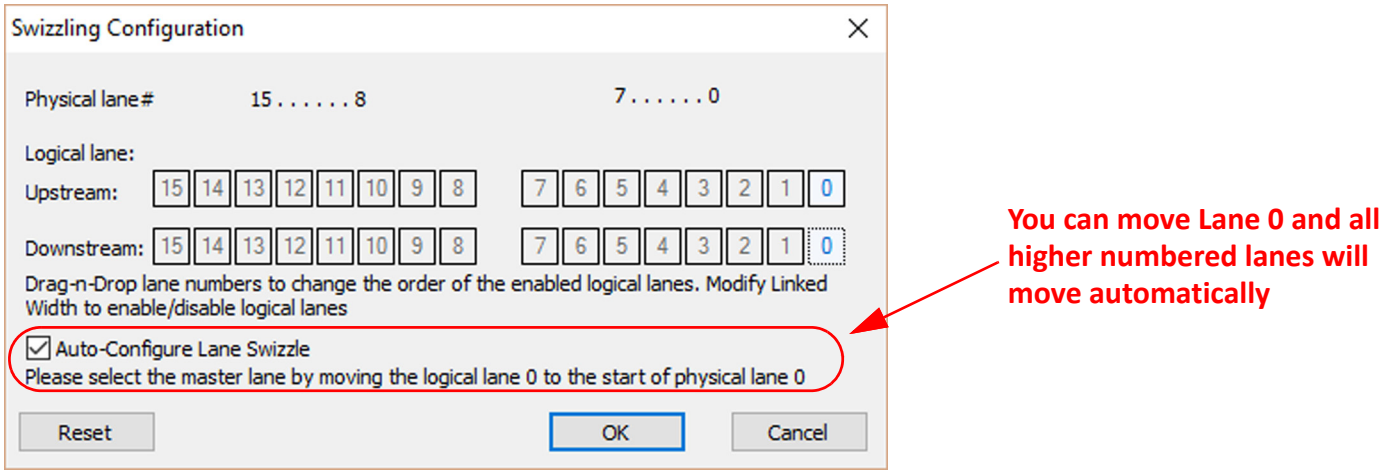


Figure 5.33: Swizzling Config Dialog

When the Auto-Configure Lane Swizzle option is checked the Summit Analyzer requires you to provide the physical location for at least one lane with active traffic. You can specify this by moving the enabled lane L0 to the physical location where either lane 0 is or any other active lane for the link. See Figure 5.34 on page 261.

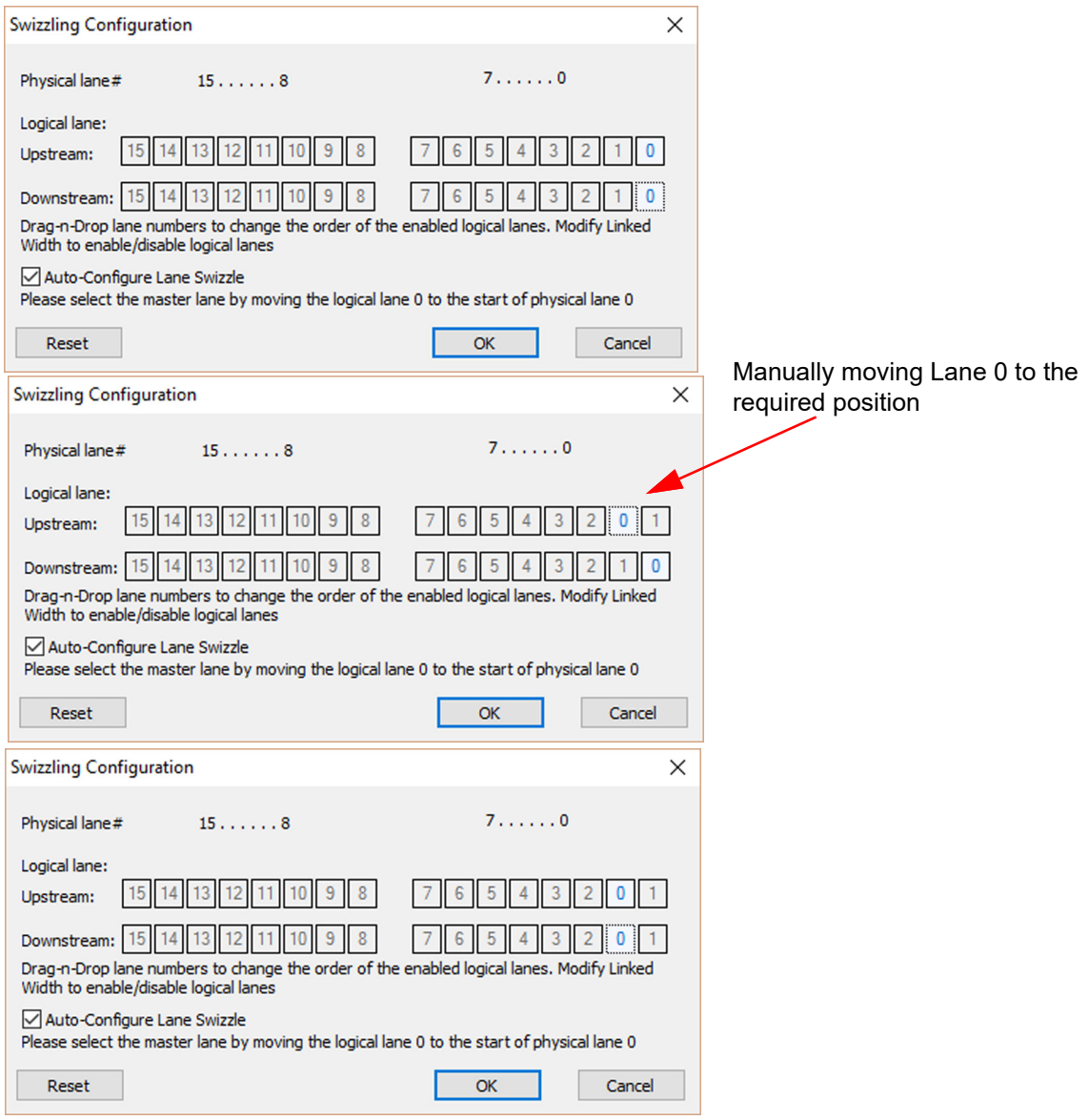


Figure 5.34: Manually Configuring Lane 0 when Auto-Configure Lane Swizzle is Checked

Note: Auto-Configure Lane Swizzle will not work properly if the link is bifurcating. Use manual swizzle instead.

5.12 Triggering

Triggering Options can be set in both Simple and Advanced Modes. The options in both modes are the same, only the GUI is different where shortcuts for the events are displayed in the Simple Mode for easy access (see Figure 5.4 on page 221).

In the Advanced Mode triggering is set up via the recording rules which allow greater flexibility to create advanced sequences you would like the analyzer to look for. These recording rules are not available in the Simple Mode. The Simple Mode allows you to simply define triggering by checking the boxes.

Note: Ensure that the correct analyzer is selected for the right options.

5.12.1 Triggering On (Simple Mode)

You can check any of the boxes shown in Table 5.5 for Trigger On in Simple Mode (see Figure 5.35 on page 263).

TABLE 5.5: Simple Mode Trigger On Events

Enter Elec Idle	NAK
Exit Elec Idle	PM
CLKREQ#	Any TLP
WAKE#	Config
PERST#	Memory
Switch to G1	IO
Switch to G2	Message
Switch to G3	RD Error
Link Width Change	Invalid Symbol
TS1	Block Align Error
TS2	Token Error
InitFC1	Idle Symbol Error

Note: Trigger Position slider becomes enabled only when Recording Type is set to Manual Trigger or Event Trigger.

Note: If you check 2 or more boxes the triggering will occur based on **any** of selected conditions (**not all** of the selected conditions).

Note: External Input Trigger is not configurable, it will always cause the analyzer to trigger on a toggle (change in level: Low to High or High to Low) when using “Manual Trigger” (see “Manual Trigger” on page 235) or triggering on any “Event Trigger” (see “Event Trigger” on page 235).

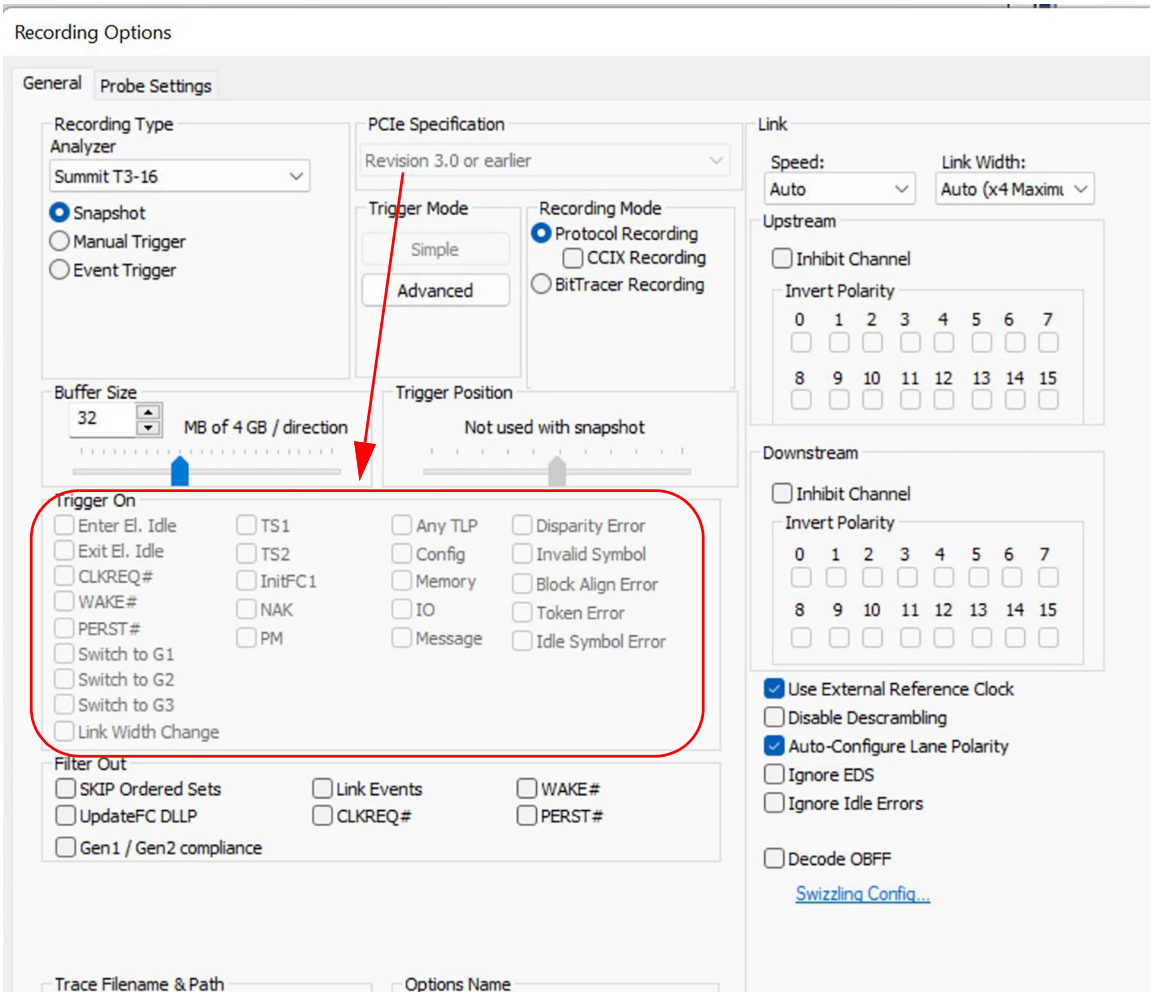


Figure 5.35: Simple Mode Triggering Options

5.12.2 Triggering On (Advanced Mode)

The same triggering options are available in the Advanced Mode as in the Simple Mode. The Advanced Mode gives you additional flexibility to drill down and configure these options in greater detail via the Recording Rules dialog.

In the Advanced mode click on the Recording Rules tab to configure the settings. As shown in Figure 5.36, the Recording Rules tab allows you to create New Events. For each event you can create Actions. A detailed explanation of the Recording Rules is given in the following sections.

Note: The External Input Trigger is combined with any other trigger defined in the sequencer.

Note: External Input Trigger is not configurable, it will **always** cause the analyzer to trigger on a toggle (change in level: Low to High or High to Low) when using "Manual Trigger" (see "Manual Trigger" on page 235) or triggering on any "Event Trigger" (see "Event Trigger" on page 235).

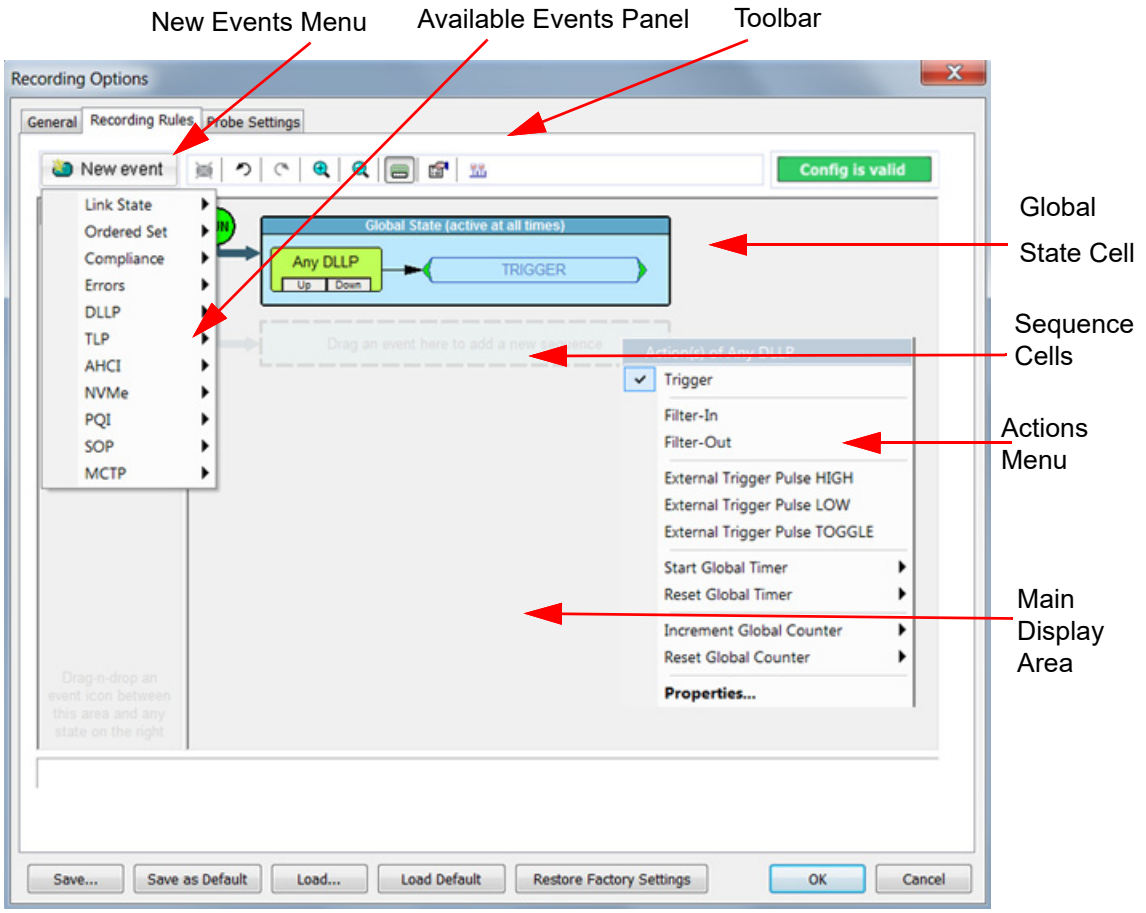


Figure 5.36: Recording Rules Tab

5.13 Navigating Recording Rules

The Recording Rules window has three main areas, the Toolbar, Available Events panel and the Main Display panel (see Figure 5.36 on page 264).

5.13.1 Toolbar

The toolbar contains buttons such as the New Events button for issuing commands, Delete Current Event, Undo, Redo, Zoom in and out, Show/Hide Channels, Properties, and Lane Trigger Configuration.

5.13.2 Available Events Area

The Available Events area is in the left repository panel where you can park buttons that you intend to use in the Main display area. The events in this panel do not affect the recording. You can drag and drop events in the Main Display panel.

5.13.3 Main Display Area

The Main Display area is the right panel where you create trigger and filter conditions. You create conditions by dragging buttons onto the Main display area from the Available Events area. You then create additional conditions by right-clicking a button and selecting options from a pop-up menu. See Creating Recording Rules.

5.13.4 Recording Rules Buttons

The Recording Rules toolbar allows you to create and edit recording rules:



TABLE 5.6: Recording Rules Toolbar Buttons

	New Event. Opens a drop-down menu with a list of events.		Zoom in
	Delete. Delete selected event.		Zoom out
	Undo. Undoes last action.		Show/Hide Channels. Shows/hides the channel buttons.
	Redo. Undoes last Undo command.		Show properties. Opens the Properties dialog for the selected item.
	Lane Trigger Configuration: Sets lane pre-conditions for event categories.		

5.14 Recording Rules Overview

The Recording Rules allows you to specify complex triggering and filtering options. The Summit T3-16 monitors incoming traffic and looks for specified events. It performs actions like triggering and filtering. Complex options can be created by putting Events in a sequence.

Events are based on Resources (see “Resources” on page 269).

5.14.1 Defining Recording Rules

The Recording Rules page is used to set triggers and filters. To access this page, select **Setup > Recording Options > Recording Rules**.

You can also access the New Event menu by right-clicking in the blue space in the Global State or in the Sequence State (see Figure 5.37 on page 267).

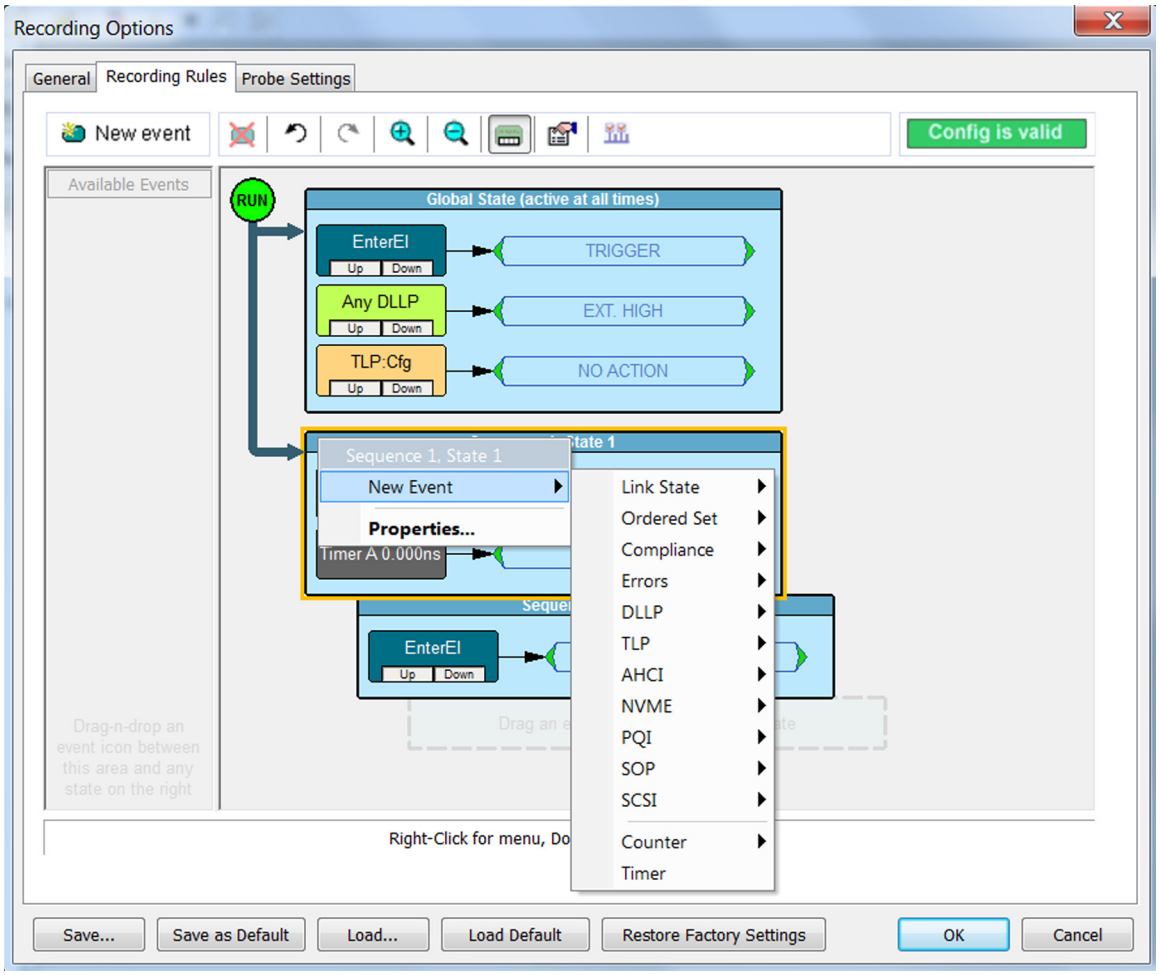


Figure 5.37: Defining New Events

There are three steps to creating a recording rule:

1. Select events.
2. Place the events in the Global State or Sequence cells.

3. Assign actions to the events.

Note: There are limits to the types of rules that can be created.

1. Click 

and select one or more events from the menu (see Figure 5.38 on page 268). Selecting an event automatically places it in the Available Events area. This repository area serves as a parking lot where you can place event buttons without them having any effect on the Analyzer.

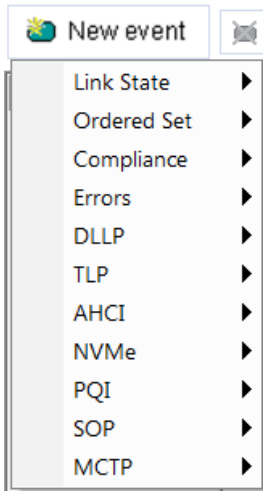
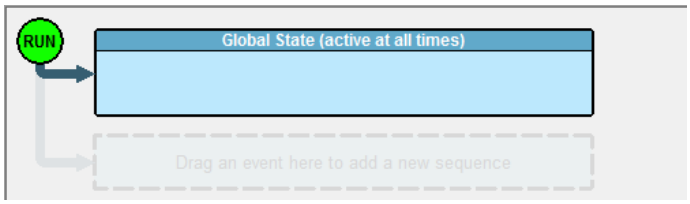


Figure 5.38: New Event Menu

2. Drag the selected events from the Available Events area into either the Global State Cell or the Sequence Cell (see “Recording Rules Overview” on page 267).



Global State Cell

If you want the Analyzer to always search for the event, place it in the cell marked **Global State**.

Sequence Cell

To create an event sequence, place two or more events in the faintly marked cell that reads **Drag an event here to add a new sequence**. At this point, the selected events have no effect because an action has not been assigned.

3. To select a sub-set of your selected event, right-click it and choose **Properties**. A Properties dialog opens that presents additional options. For example, if you open the Properties dialog for Errors, you can set the specific types of errors the Analyzer should look for.

4. Assign an action to the selected events by right-clicking each of the events, selecting **Specify Action** from the pop-up menu, and assigning an action such as **Trigger, Filter**, or **Count**. Be sure to click the event itself and not the **State** cell that it is sitting in (which produces a different pop-up menu).

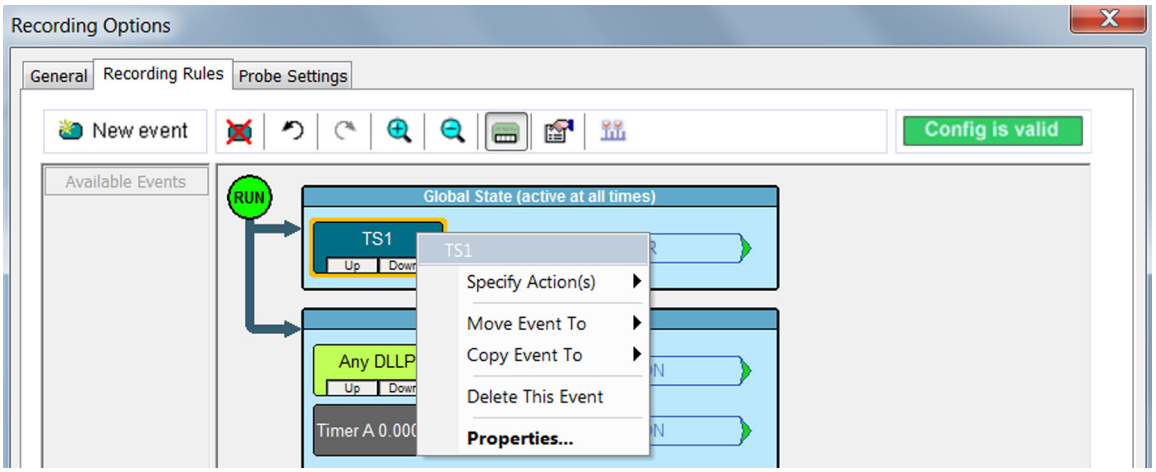


Figure 5.39: Assigning an Action

Note: You can also assign actions to events by double-clicking the event or action and selecting the Actions page when the Properties dialog opens (see "Event Properties Dialog Box Features" on page 287).

Click **OK** to close the dialog. At this point, assuming that the other options in the Recording Options dialog have been set (such as the General page), you can begin the recording by pressing the Start **Recording** button.

5.14.2 Resources

Events in Recording Rules are based on Resources. There are three types of Resources. They are Packet Match Resources, Basic Resources and Payload Match Resources.

These Matchers are hardware specific resources that are programmed internally to capture specified events and are not available to the user. Although they can be programmed to capture a wide variety of events you can define a very complex set of events which would need more resources than are available. It that case the Configuration button at the top right of the Recording Options dialog box will show Config is invalid .

If you click on the "Config is Invalid" box a detailed Warning message will pop up. See Figure 5.40 on page 270. In this case, too many basic resource events were defined in the Global State.

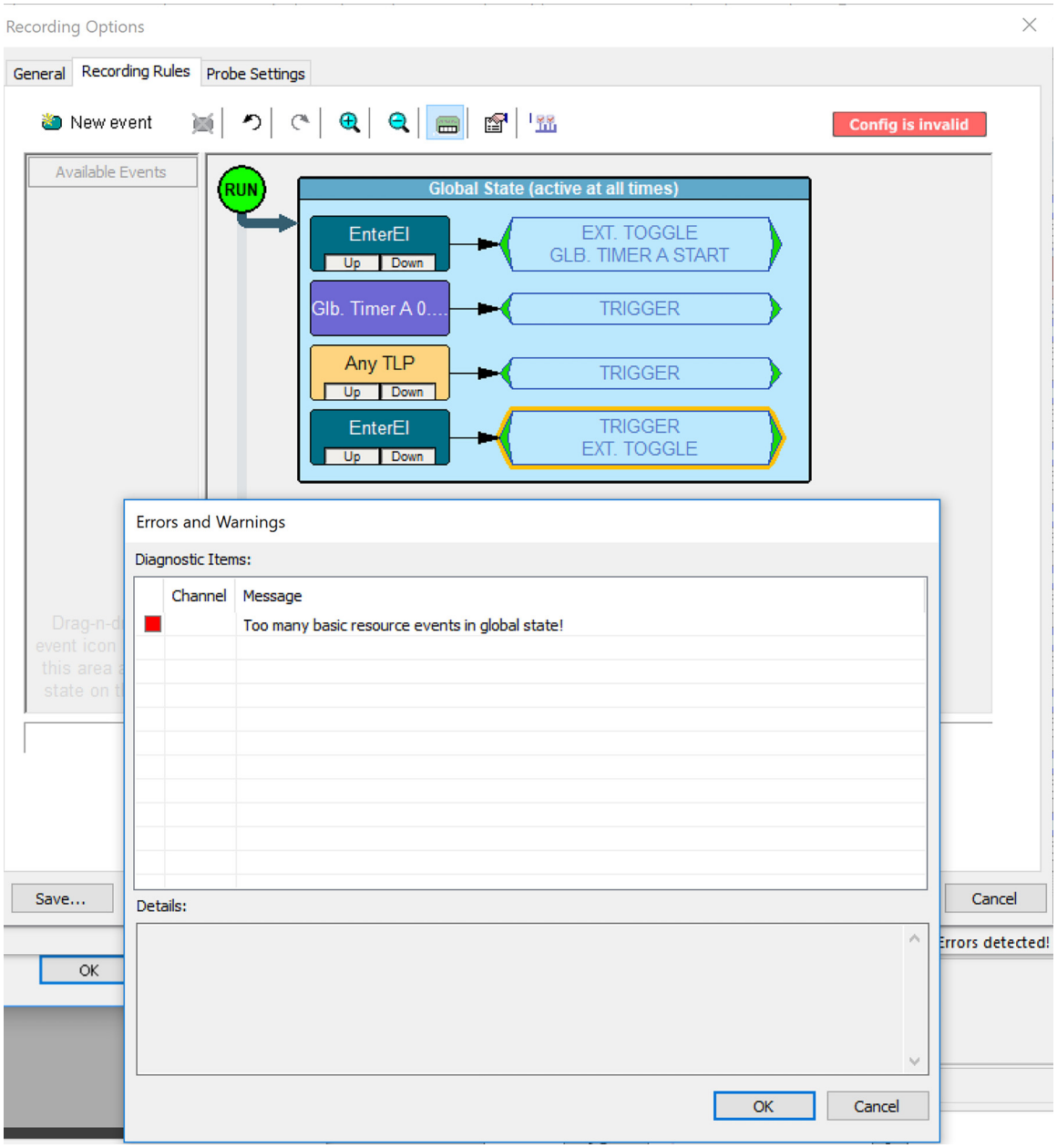


Figure 5.40: Config: Invalid -> Shows Warning Message

If you define a set of events that are missing actions or have inherent contradictions you'll see the Configuration button show **Config warnings** . If you click on the Configuration button it will produce a list of issues that will need to be corrected before you get the **Config is valid** .

5.14.2.1 Packet Match Resource

Packet Match Resources are for the TLP, DLLP, TS1 and TS2 events as well as some of the storage protocol trigger options such as AHCI Register, NVMe Register, PQI Register and SOP IU Type. A Packet Match Resource allows you to define not only packets but it also allows you to define each specific bit in a packet. In the Packet Match resource you can define the exact layout to the bit level so that the Analyzer can match the exact pattern that applies to a TLP, DLLP, TS1 or TS2 event.

To set a Packet Match Resource, click on the **New Event** button and select any of the options. In this case we have selected **DLLP: InitFC1**. The **DLLP: InitFC1** displays in the **Available Events** panel. Double-click on the **DLLP: InitFC1** to select the specific fields and go to the Layout tab to change the pre-defined bits. After selecting the options you want click on the “OK” button.

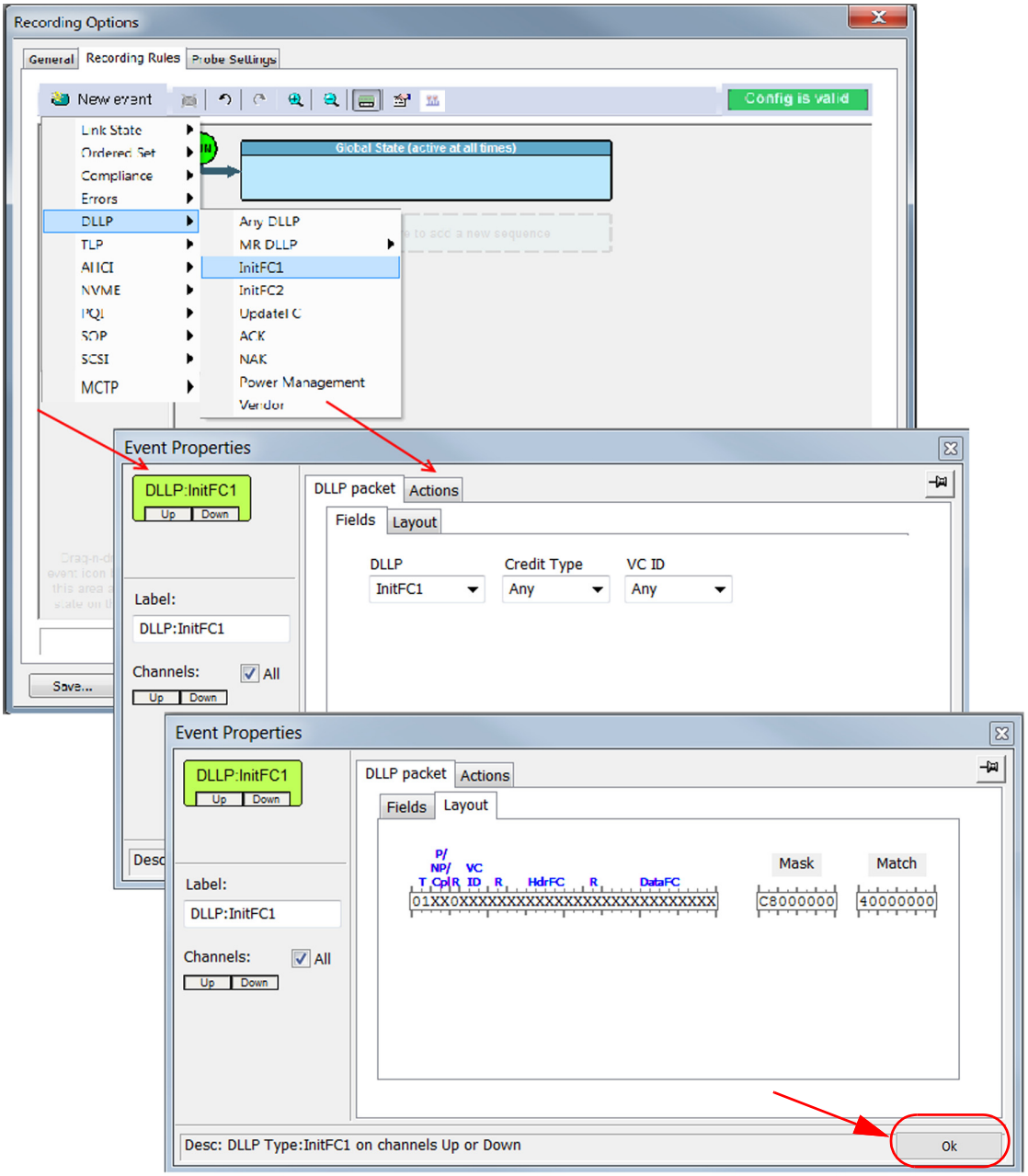


Figure 5.41: Setting Up a Packet Match Resource - DLLP

To set a TS1 Packet Match Resource, click on the **New Event** button and select **Ordered Set: TS1**. The **Ordered Set: TS1** displays in the **Available Events** panel. Double-click on the **TS1** to select the specific fields and go to the Layout tab to change the pre-defined bits.

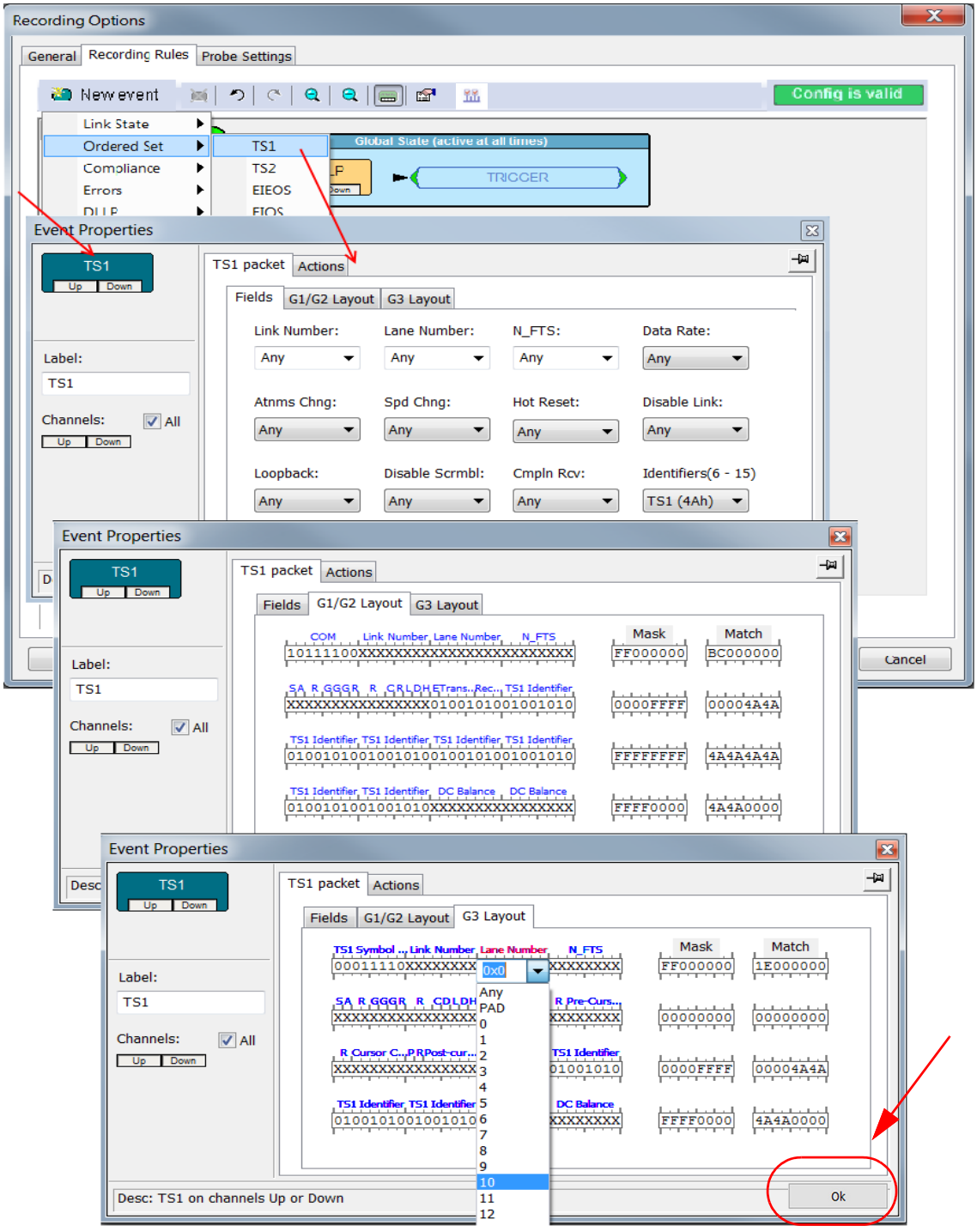


Figure 5.42: Setting Up a Packet Match Resource - TS1

Defining Gen3 Layout tab does not mean the that analyzer will trigger on a TS that happens just at Gen3. Gen3 Layout will allow you to define the bits but if these bits are matched at any other speed the analyzer will trigger.

5.14.2.2 Basic Resource

Basic Resources are for the Link States, Ordered Sets (except TS1 and TS2) and Errors. A Basic Resource does not allow you to define patterns to the bit level. It just matches events that have been predefined.

To set a Basic Resource, click on the **New Event** button and select any of the options. In this case we have selected **Ordered Set: EIEOS**. The **EIEOS** displays in the **Available Events** panel. Double-click on the **EIEOS** to select other Ordered Set events and go to the Actions tab to configure specific Actions. After selecting the options you want click on the "OK" button.

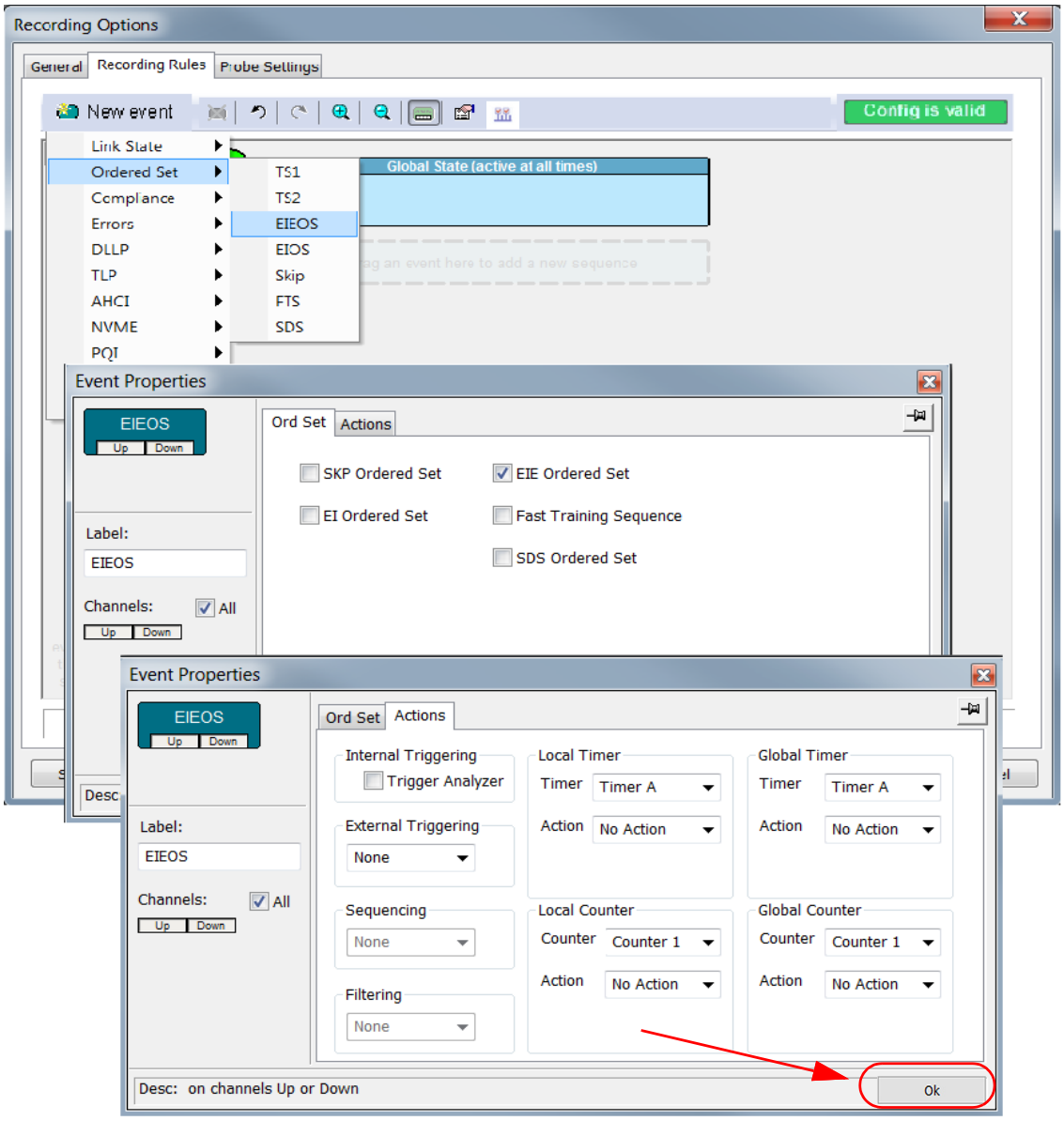


Figure 5.43: Setting Up a Basic Resource

5.14.2.3 Payload Match Resource

Payload Match Resources are available for TLP events only. A Payload Match Resource allows you to define up to five double-words of payload content to be matched for any TLP. These five double-words can be floating, meaning the payload of any TLP will be analyzed five double-words at a time for all double-words offsets in the payload. There is also an option (defined as fixed) you can select so that only the first five double-words are of a payload will be analyzed. You can define the layout to the bit level in the Payload tab so that the Analyzer can match an exact pattern.

To set a Payload Match Resource, click on the **New Event** button and select **TLP Payload**. The **TLP Payload** displays in the **Available Events** panel. Double-click on the **TLP Payload** to select other **TLP Payload** to display the Payload tab. See Figure 5.44 on page 276 for the TLP Payload tab, Figure 5.45 on page 277 for the TLP Floating Payload and Figure 5.46 on page 278 for the TLP with a Fixed Payload. See Figure 5.47 on page 279 which shows the TLP Payload matching the defined data pattern. After selecting the options you want click on the “OK” button.

The Actions tab to configure specific Actions can be seen in Figure 5.48 on page 280. After selecting the options you want click on the “OK” button.

There are up to 8 Payload Match resources that can be used independently of the other resource types for the Summit T3-16, T3-8 and T34.

There are up to 6 Payload Match resources that can be used independently of the other resource types for the Summit T28. The Summit T24 does not support Payload Matching.

Storage trigger options ATA Command, NVMe Command Submission and NVME Command Completion, PQI Command, all SCSI commands sets are based on Payload Match Resources.

Note: The TLP Payload option will be available only if the Link Width is selected as fixed/auto X1, X2 or X4 in the recording options.

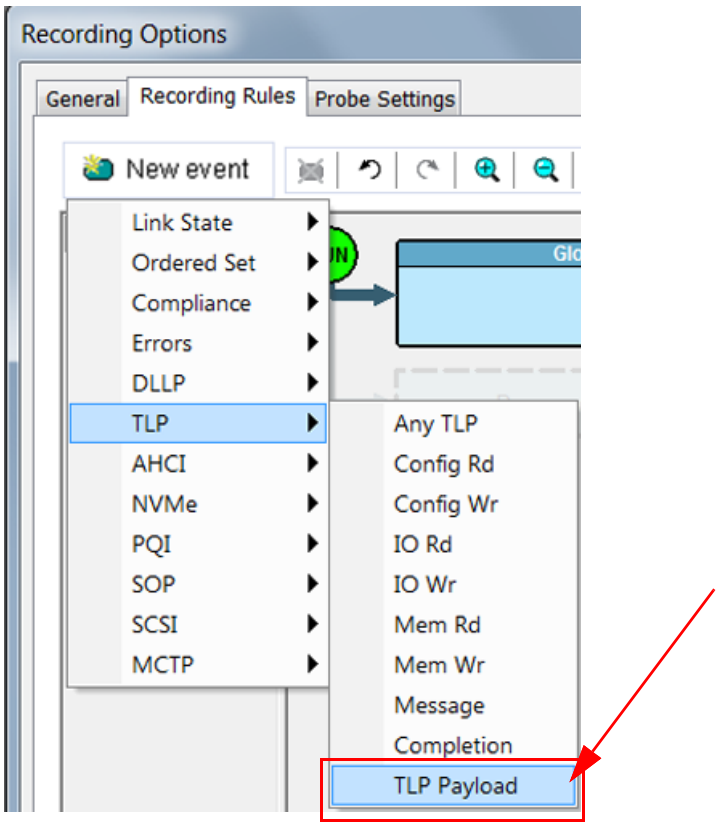


Figure 5.44: Setting Up a Payload Match Resource 1

TLP Floating Payload

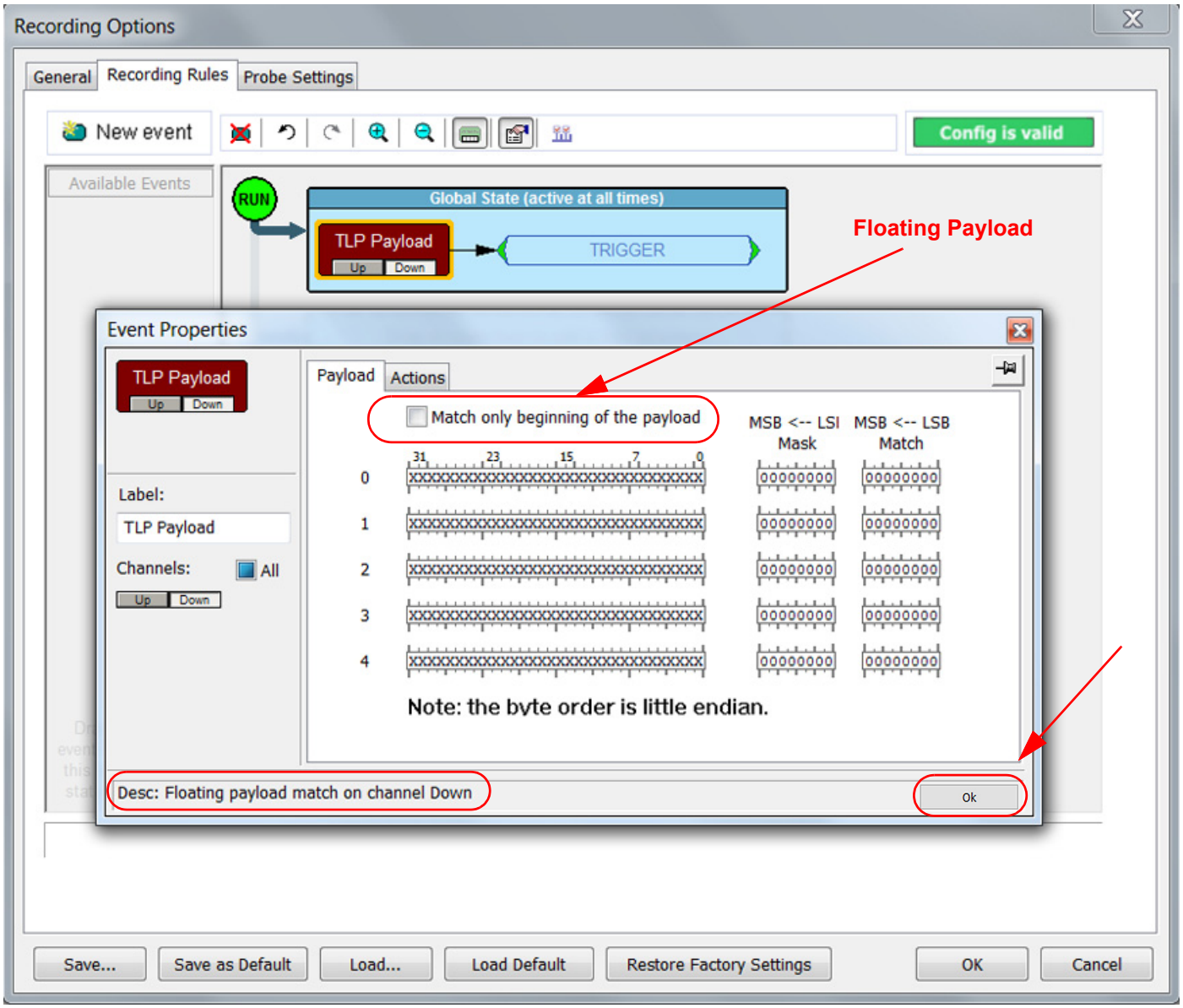


Figure 5.45: Setting Up a Payload Match with Floating Payload

TLP Fixed Payload

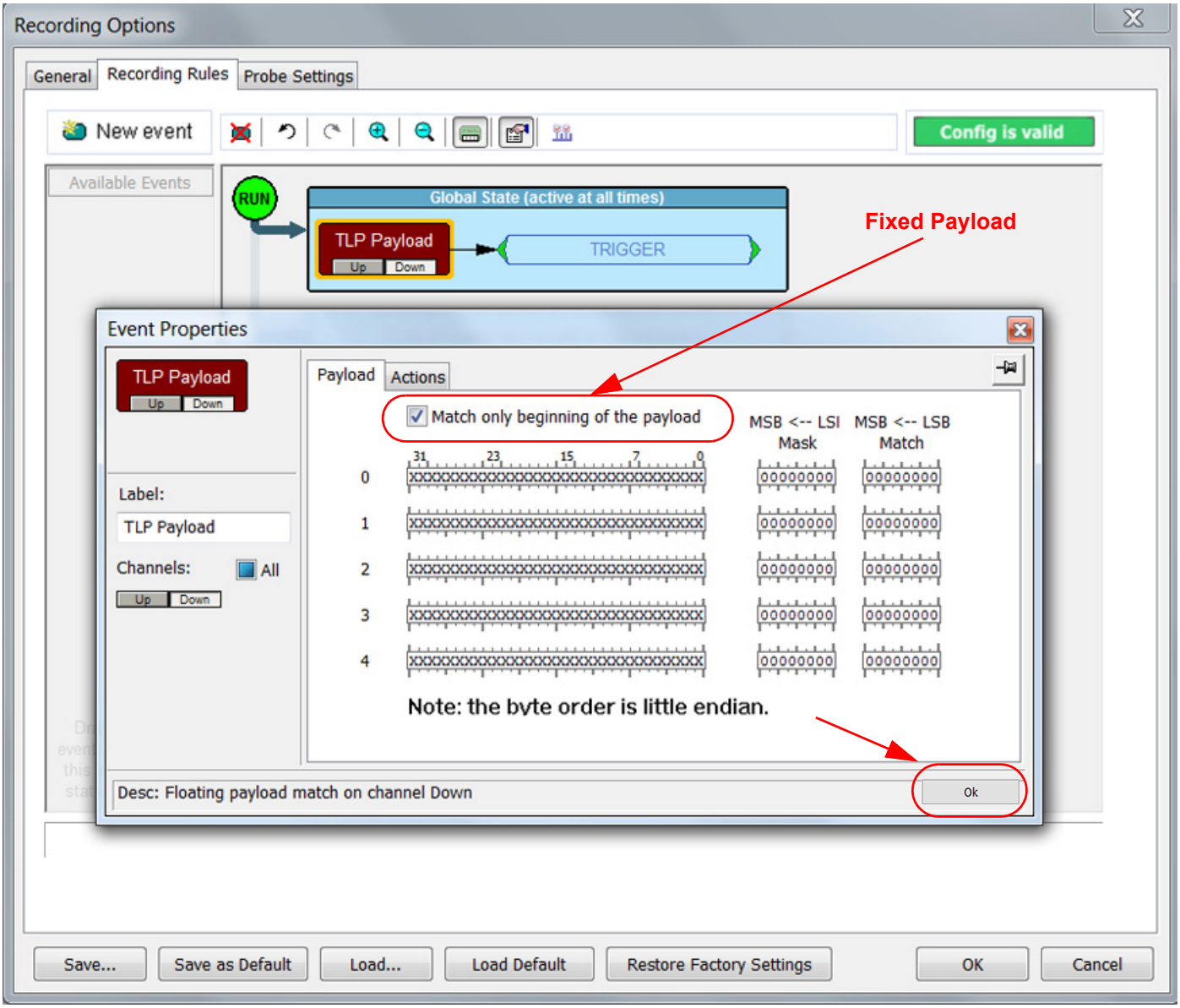


Figure 5.46: Setting Up a Payload Match with Fixed Payload

Payload Match Example

The payload match pattern byte ordering is always little-endian while the data payload display in the CATC Trace is big-endian (see Figure 5.47 on page 279). The CATC Trace is configurable, so you need to exercise caution in order to specify the matching pattern properly. After selecting the options you want click on the “OK” button.

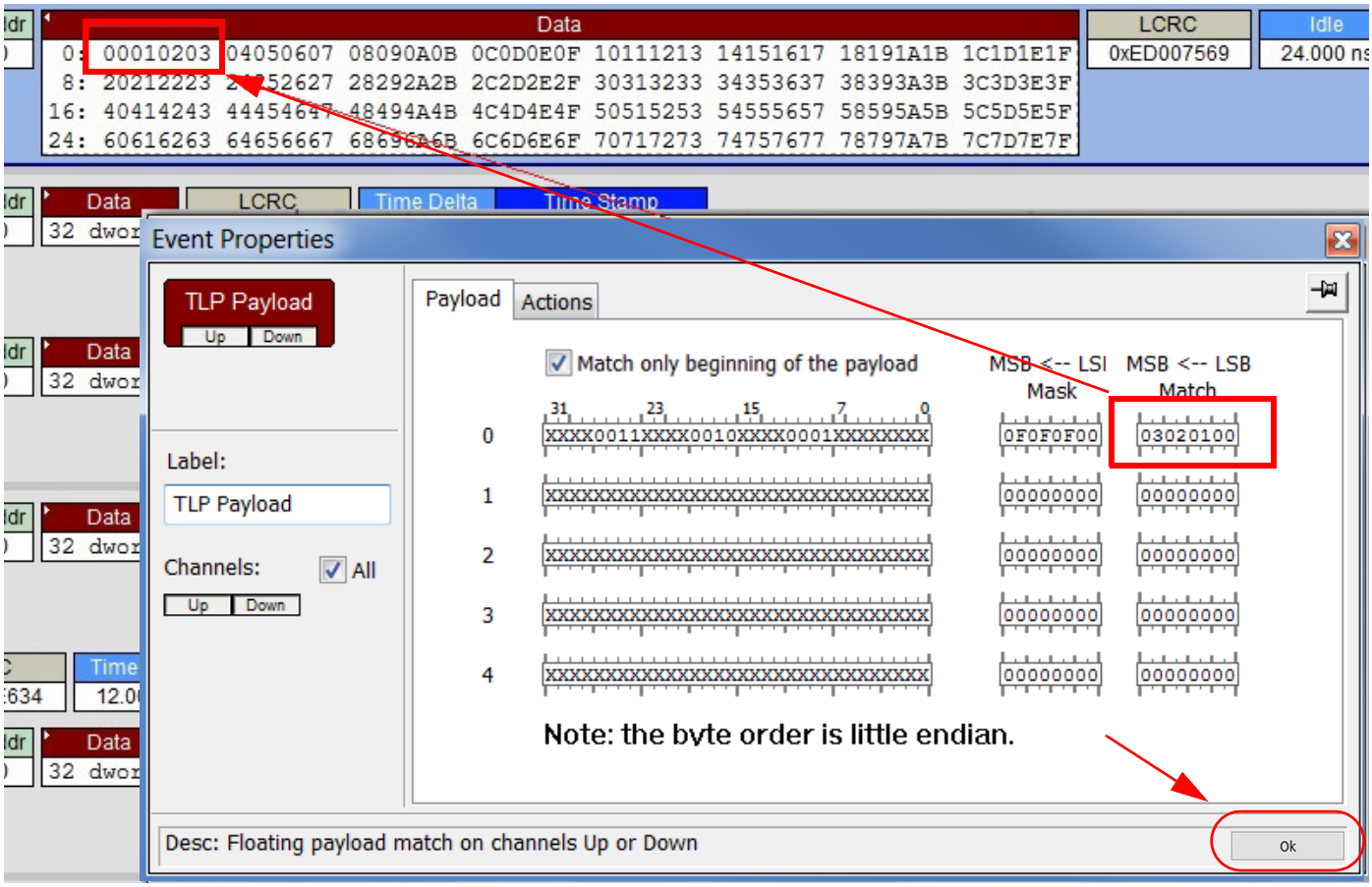


Figure 5.47: Match Pattern Causing a Trigger

ACHI Register and NVMe Register trigger options are based on TLP packet match resources.

TLP Payload Actions

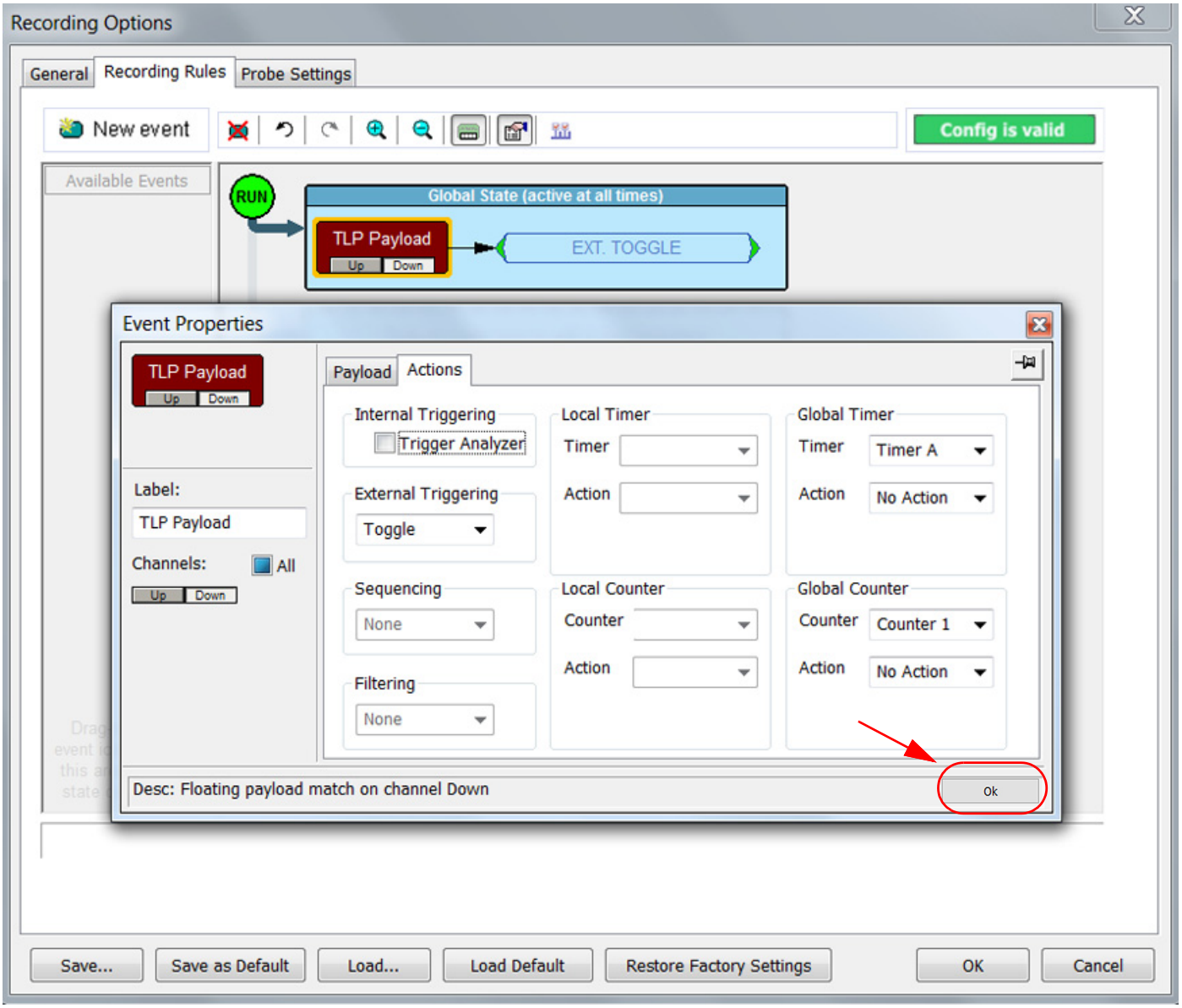


Figure 5.48: Setting Up a Payload Match Actions

5.14.3 Global State and Sequence States

The Main Display area in the center of the Recording Rules window has two cells that affect events differently, they are the Global State and Sequence State.



Figure 5.49: Global State Cell and Sequence State Cell

In the Global and Sequence State you can add events by clicking on the New Event button and after the event is in the State you can right-click to Specify Actions, Move, Copy or Delete the event. You can view the Properties dialog to make additional changes to the Property of the event (see Figure 5.49 on page 281). The description of these actions are given in Table 5.8 on page 321.

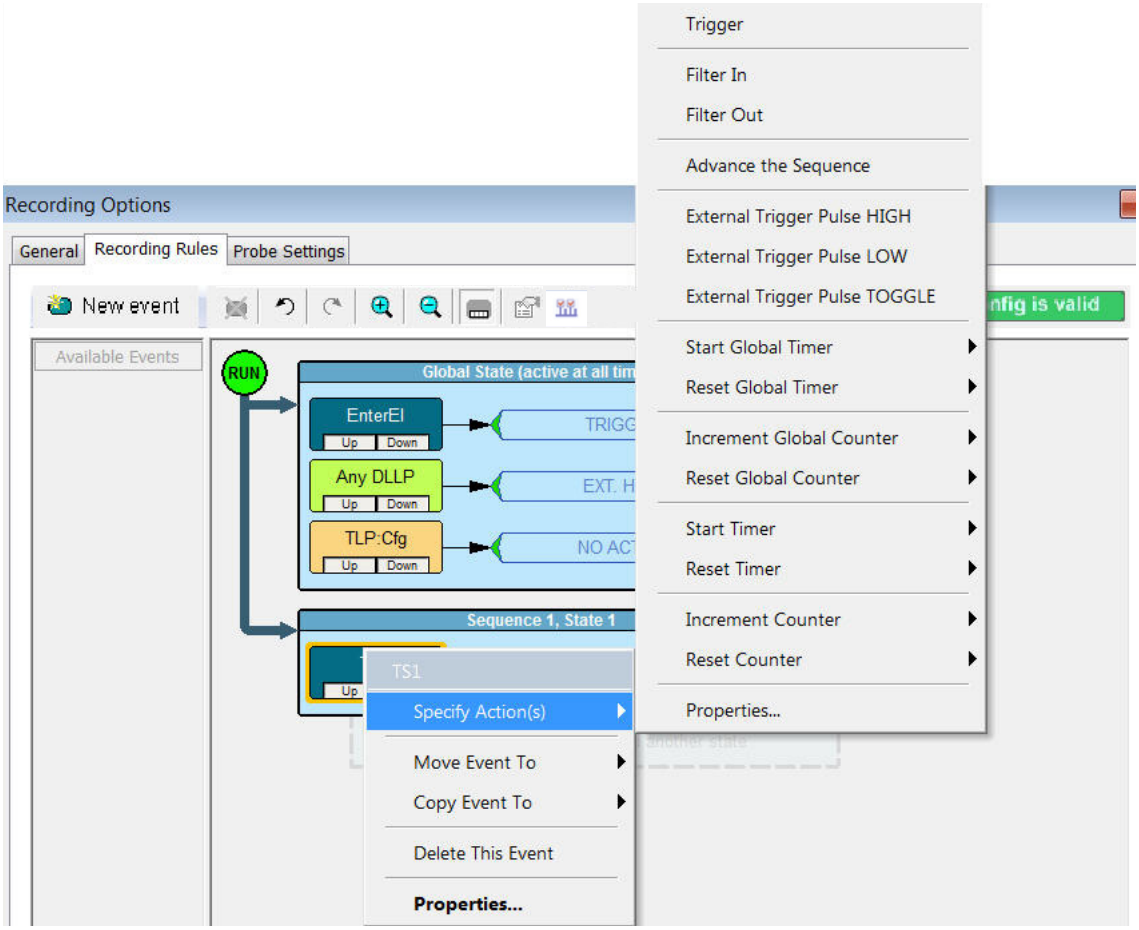


Figure 5.50: Global State Menu

5.14.3.1 Global State

The Global State is active all the time. The Summit T3-16 Analyzer tracks all the Events and Actions defined in the Global State throughout the recording. In the Global State the Link State, Ordered Set (except TS1 and TS2), Errors, Counter and the Timer use Basic Resources while TLP, DLLP, TS1 and TS2 use Packet Match Resources. The Global State has two Timers and two Counters.

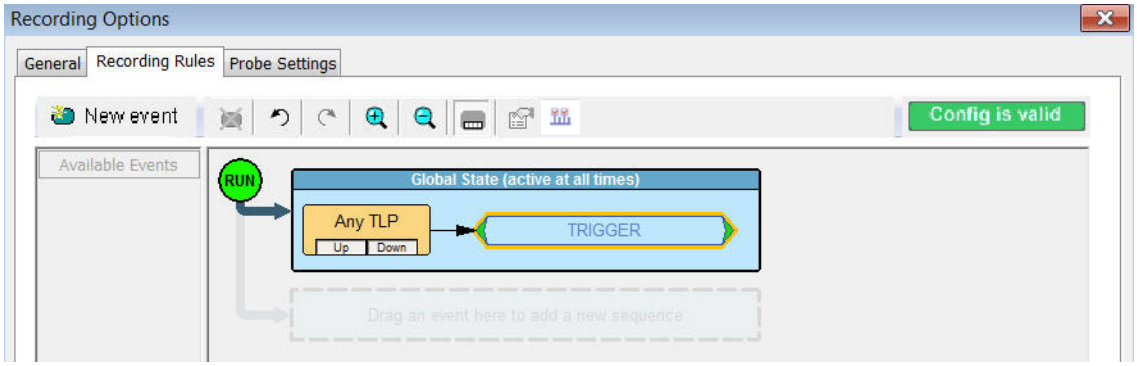


Figure 5.51: Global State

For the Global State there are only 2 Basic Resources for each Channel. Some optimization is done internally to accommodate additional resources. You can keep adding resources to the Global state so long as the **Config is valid** button stays green. If you add a new event which is not valid a window appears with a message prompting **Invalid Recording Rules Configuration** and the **Config is valid** button will turn red (see Figure 5.52 on page 283).

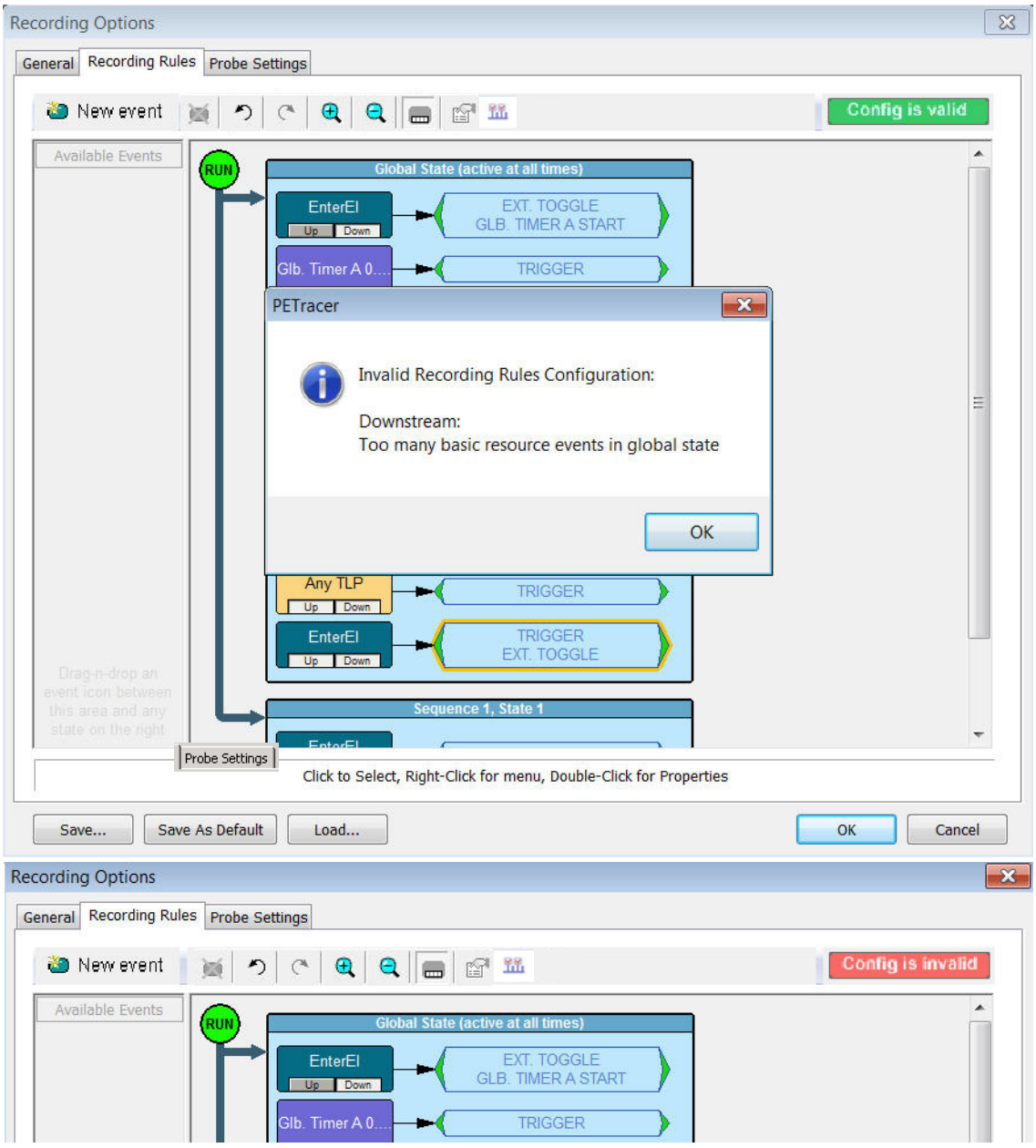


Figure 5.52: Valid and Invalid Recording Rules Configuration Dialogs

5.14.3.2 Sequence State

The cell marked **Drag an event here to add another sequence** is the Sequence State (see Figure 5.53). In the Sequence State you can define a sequence of Events and Actions which the Summit T3-16 Analyzer looks for at pre-determined times. Sequences are chains of events culminating in a trigger or any other action. A sequence which is a separate chain of events can be created with up to 16 states. A state is an event condition with an action within a sequence. Once a Sequence State is added the cell marked will read **Drag an event here to add another state.**

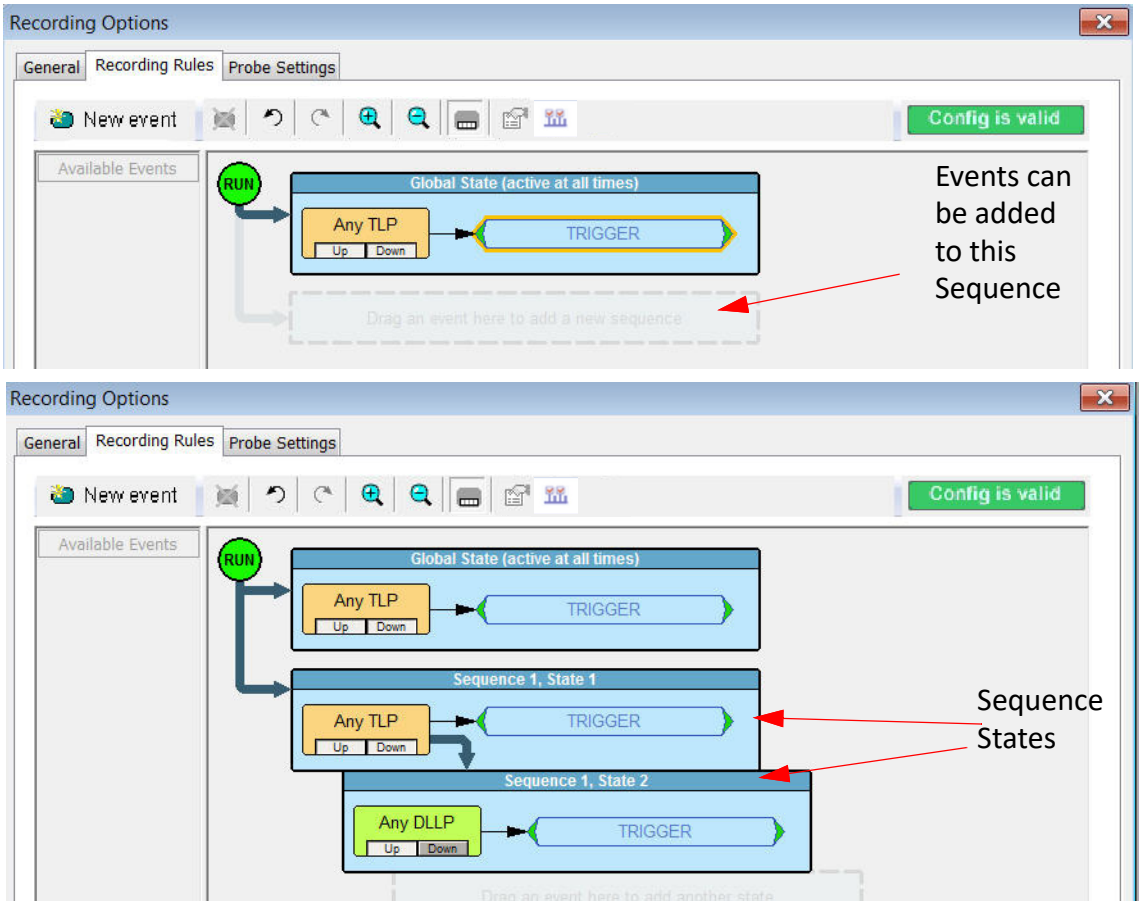


Figure 5.53: Sequence State Events

In the Sequence State the Link State, Ordered Set, Errors, Counter and the Timer use Basic Resources while DLLP and TLP use Packet Match Resources. There are four Timers and four Counters in the Sequence State.

Note: In each Sequence State up to eight Basic Resources and eight Packet Match Resources can be defined.

5.14.4 Recording Rules Events

There are eleven sets of Events that can configured and actions can be set for every Event.

TABLE 5.7: Events and Event Actions

Event	Pre-Defined Event Actions
Link State	
	Enter Electrical Idle
	Exit Electrical Idle
	Speed Switch to 2.5Gb/s
	Speed Switch to 5.0Gb/s
	Speed Switch to 8.0Gb/s
	CLKREQ# Asserted
	CLKREQ# Deasserted
	WAKE# Asserted
	WAKE# Deasserted
	LinkWidth Change to x1
	LinkWidth Change to x2
	LinkWidth Change to x4
	LinkWidth Change to x8
	LinkWidth Change to x16
	PERST# Asserted
	PERST# Deasserted
Ordered Set	
	TS1
	TS2
	EIEOS
	EIOS
	Skip
	FTS
	SDS
Compliance	
	Gen1 / Gen2
Errors	
	Idle Error
	Disparity Error
	Symbol Error
	Token Error
	Block Align Error

TABLE 5.7: Events and Event Actions (Continued)

DLLP	
	Any DLLP
	MR DLLP (MRInit, MRReset, MRUPdatFC, MRInitFC1, MRInitFC2
	InitFC1
	InitFC2
	UpdateFC
	ACK
	NAK
	Power Management
	Vendor
TLP	
	Any TLP
	Config Rd
	Config Wr
	IO Rd
	IO Wr
	Mem Rd
	Mem Wr
	Message
	Completion
	TLP Payload
AHCI	
	AHCI Register
	ATA Command
NVME	
	NVME Register
	NVME Command Submission
	NVME Command Completion
PQI	
	PQI Register
	PQI Command
SOP	
	SOP IU Type
SCSI	
	SCSI Block Command Set

TABLE 5.7: Events and Event Actions (Continued)

	SCSI Multimedia Command Set
	SCSI Media Changer Command Set
	SCSI Enclosure Services Command Set
	SCSI Controller Command Set
	SCSI Stream Command Set
	SCSI Primary Command Set
MCTP	
	MCTP Packets

Note: NVME Command, PQI Command and SCSI command sets are available for selection when Link Width option is set to X4 or lower in the Recording Options.

5.14.5 Properties Dialog Boxes for Events

Properties dialog boxes provide additional settings for Events, States, and Actions in the Recording Rules page. You can access a Properties dialog by double-clicking an **Event, State, Action** or any other object. It allows you to set triggers and filters. For example, to set a trigger on a specific type of error, you open the Properties dialog.

5.14.5.1 Accessing the Properties Dialog

To see the Properties dialog, first create an event button by clicking the **New Event** button and choosing an event from the menu. Open the Event Properties dialog by doing one of the following:

- Double-click an event.
- Right-click an event and select **Properties** from the pop-up menu.
- Click the **Properties** button on the toolbar.

5.14.5.2 Event Properties Dialog Box Features

The following features are displayed in the any Event Properties dialog box (see Figure 5.54 on page 288).

Event Icon Preview

This icon shows you which event properties you are editing. The Icon Preview looks exactly like the icon in the Main Display area.

Icon Label

A text box for labeling the button. Whatever you type here appears on the button.

Channels

These controls allow you to select the channel(s) that the Analyzer should search when it is looking for the event.

Pin Button

The Pin Button on the top right corner of the dialog allows you to **pin** the Properties dialog to the application so that it does not go away when another object appears such as an event, state or action.

Description String

This area contains a textual description of the event.

Event-specific Settings

The largest part of the Event Properties dialog. The settings in this area vary for different events. Some events do not have any additional settings. After selecting the options you want click on the “OK” button.

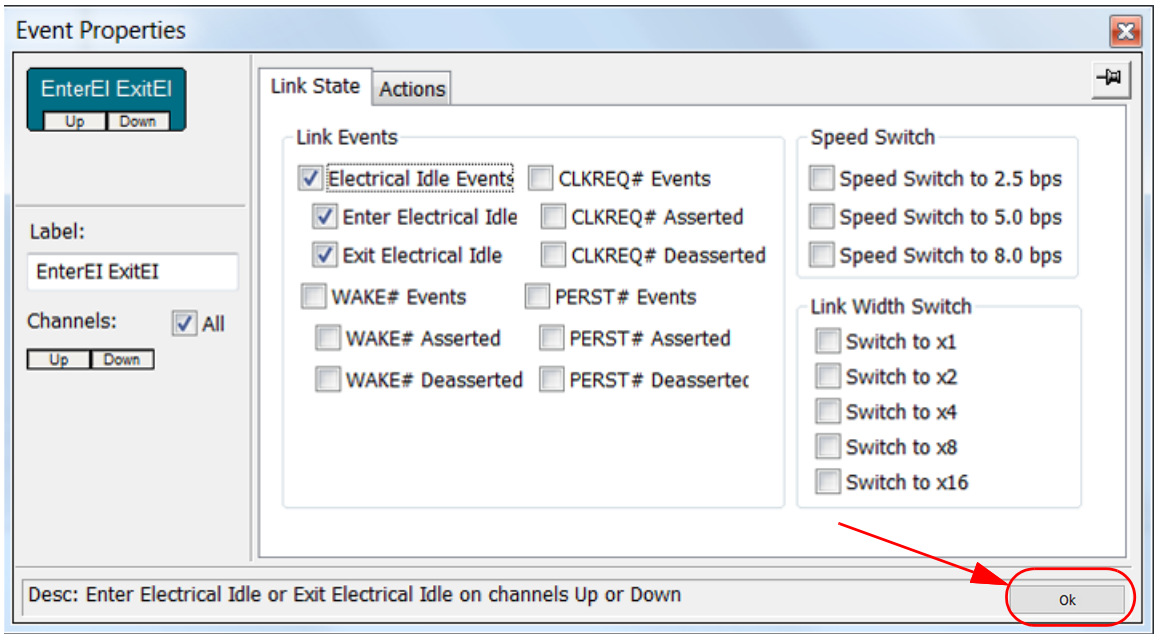


Figure 5.54: Properties Dialog Box

5.14.5.3 Link State Dialog

The Link Properties dialog lets you select the link state. In the case shown below, PERST# events are the Link States selected. See Figure 5.55 on page 289. After selecting the options you want click on the “OK” button.

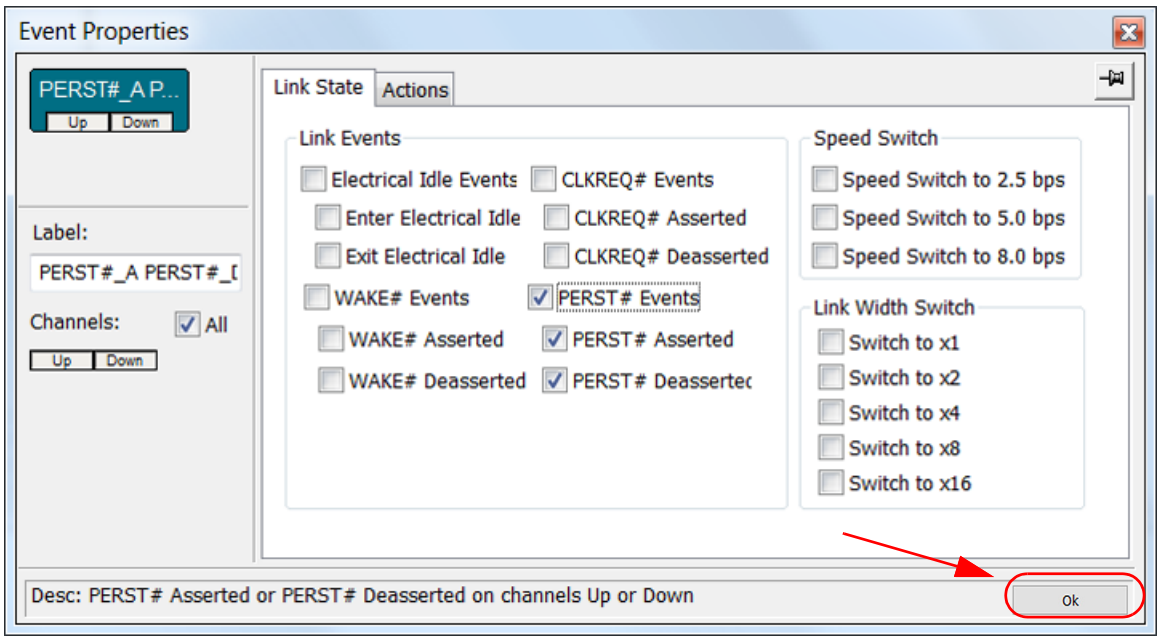


Figure 5.55: Link State Properties Dialog: PERST#.

5.14.5.4 Link State Actions

In this case, the Link State Action to be taken would be to trigger the analyzer. See Figure 5.56. After selecting the options you want click on the “OK” button.

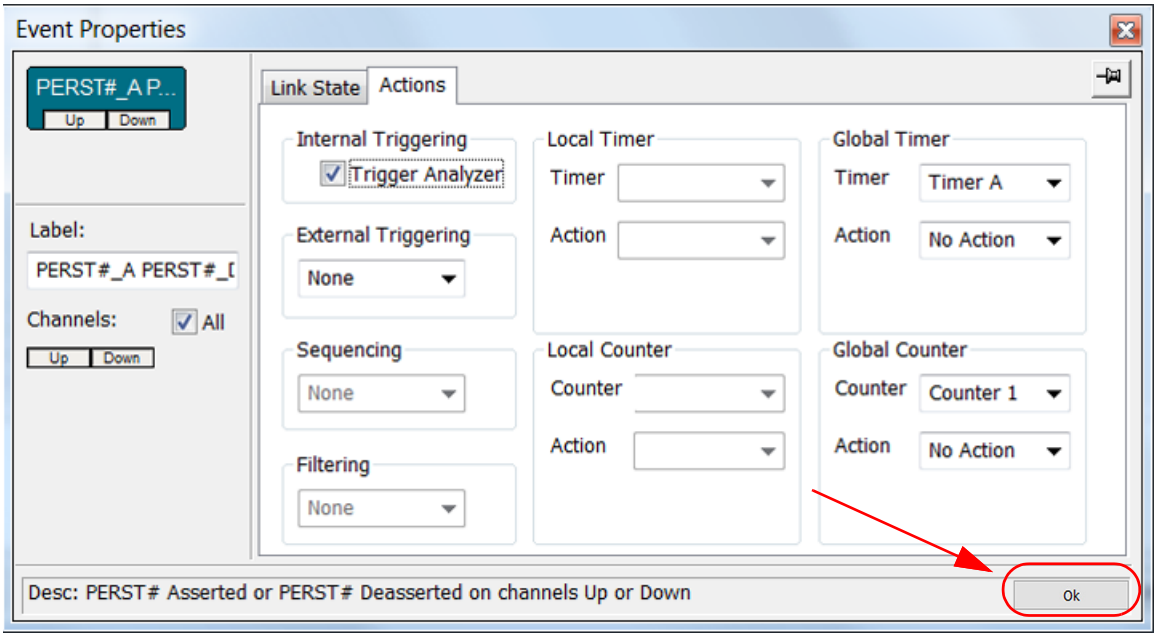


Figure 5.56: Event Properties: Link State Actions: Trigger Analyzer

5.14.5.5 Global State: CLKREQ# or PERST# Triggers

You could have either a PERST# or CLKREQ# event trigger the analyzer by applying those two conditions to the Global Settings. See Figure 5.57.

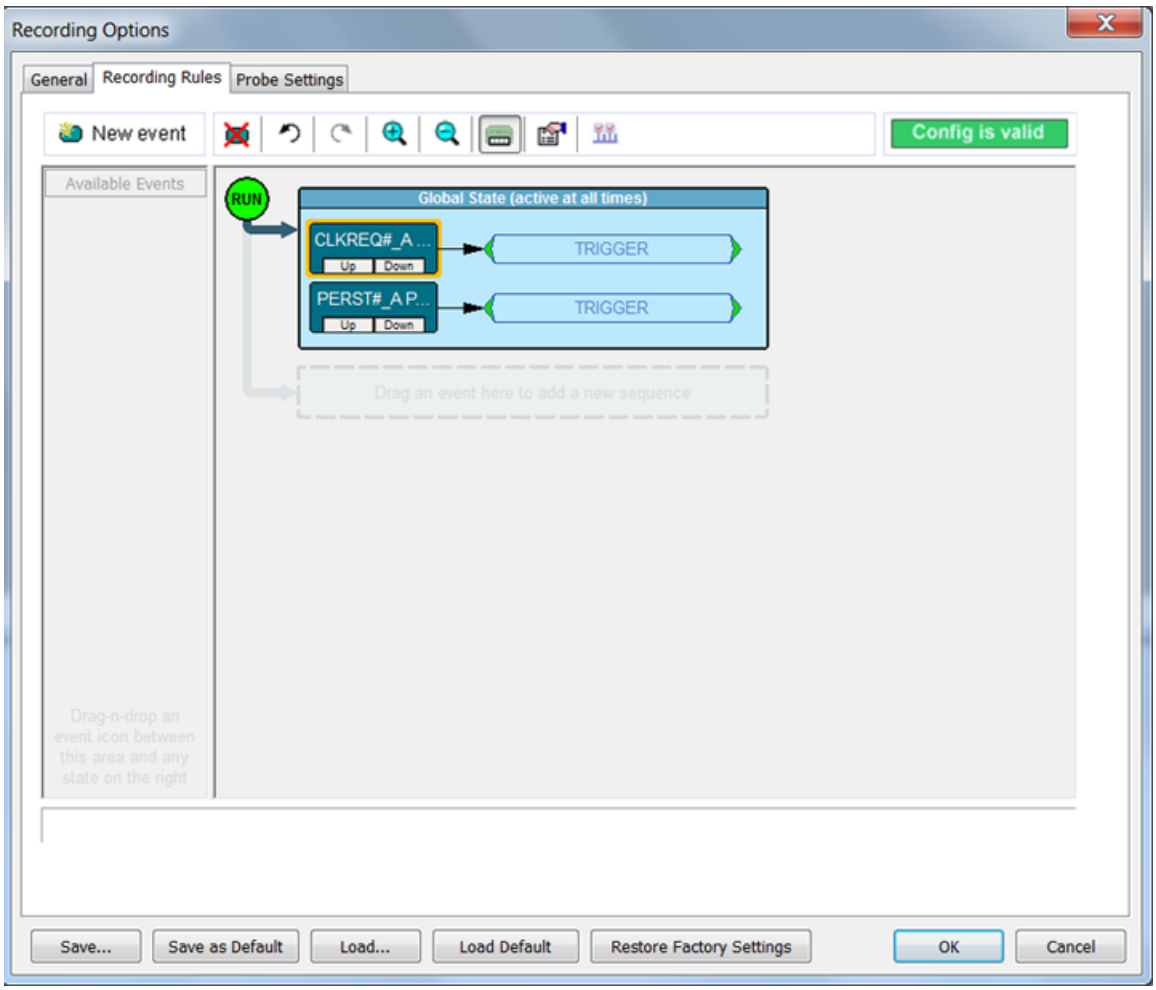


Figure 5.57: Global State: CLKREQ# or PERST# Triggers Analyzer

5.14.5.6 Ordered Sets

A typical Ordered Set Event would be a TS1 packet with the following fields:

- Link Number: Any or PAD
- Lane Number: Any, PAD or Use Lane Trigger
- N_FTS: Any
- Data Rate: Any, G1, G2, G3 or G4
- Atnms Change: Any, Set or Cleared
- Speed Change: Any, Set or Cleared
- Hot Reset: Any, Assert or De-Assert
- Disable Link: Any, Assert or De-Assert
- Loopback: Any, Assert or De-Assert
- Disable Scramble: Any, Assert or De-Assert
- Completion Received: Any, Assert or De-Assert
- Identifiers (6-15): Any, TS1(4Ah) or Custom

See Figure 5.58.

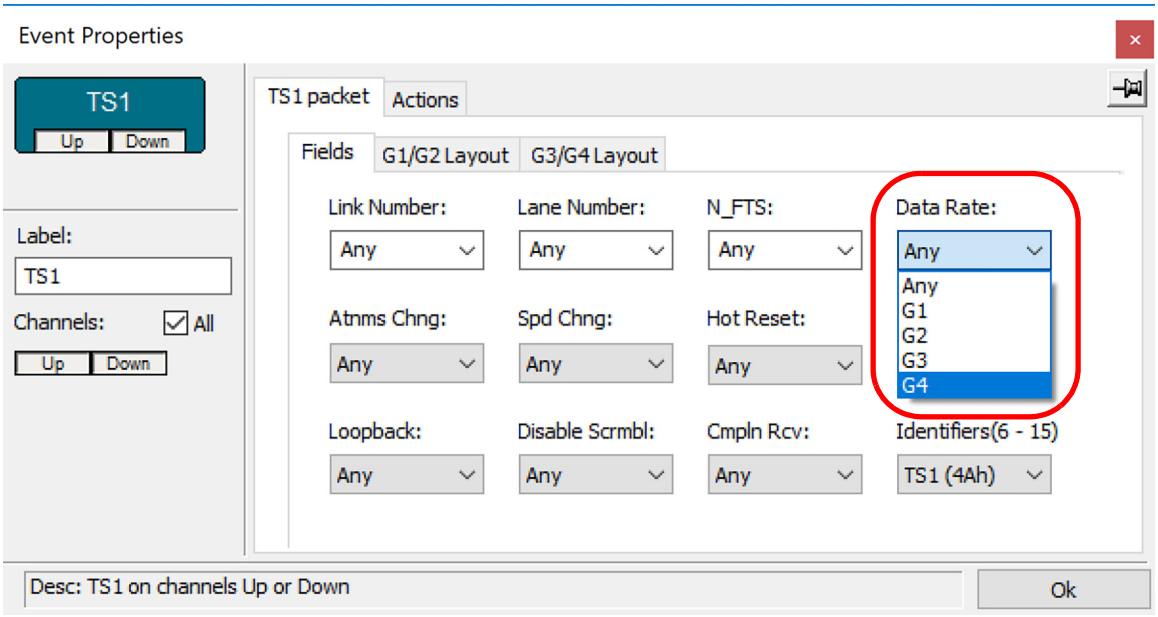


Figure 5.58: Typical Ordered Set: TS1 Event Fields

For G1/G2 Layout the options are shown in Figure 5.59 on page 292.

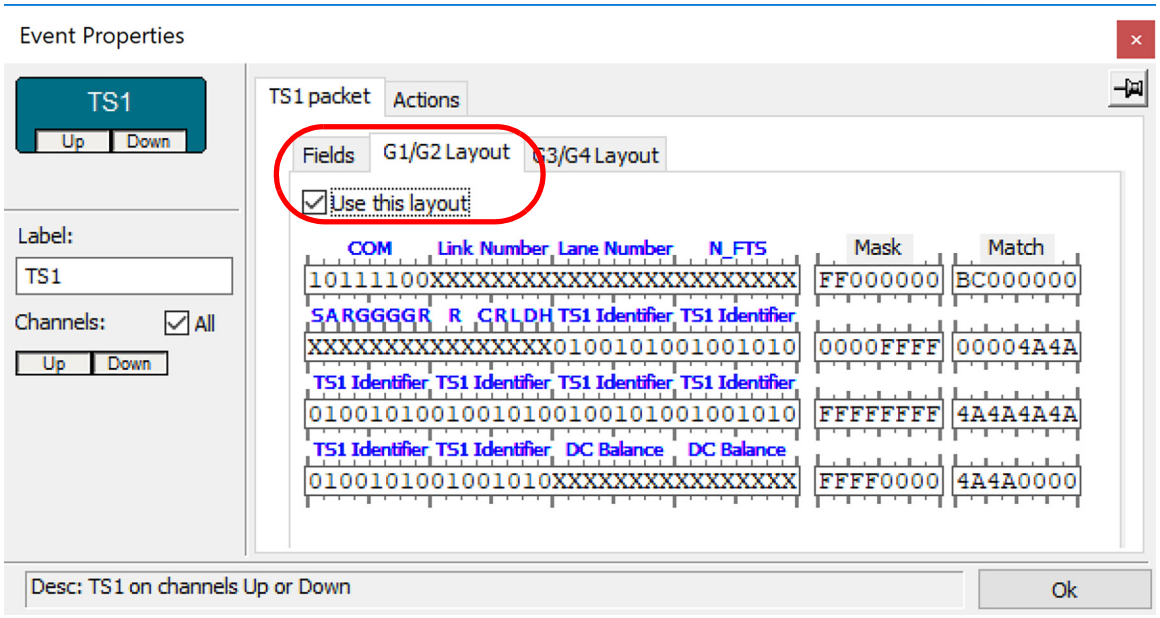


Figure 5.59: Ordered Set: TS1 -> G1/G2 Layout Options

For G3/G4 Layout the options are shown in Figure 5.60.

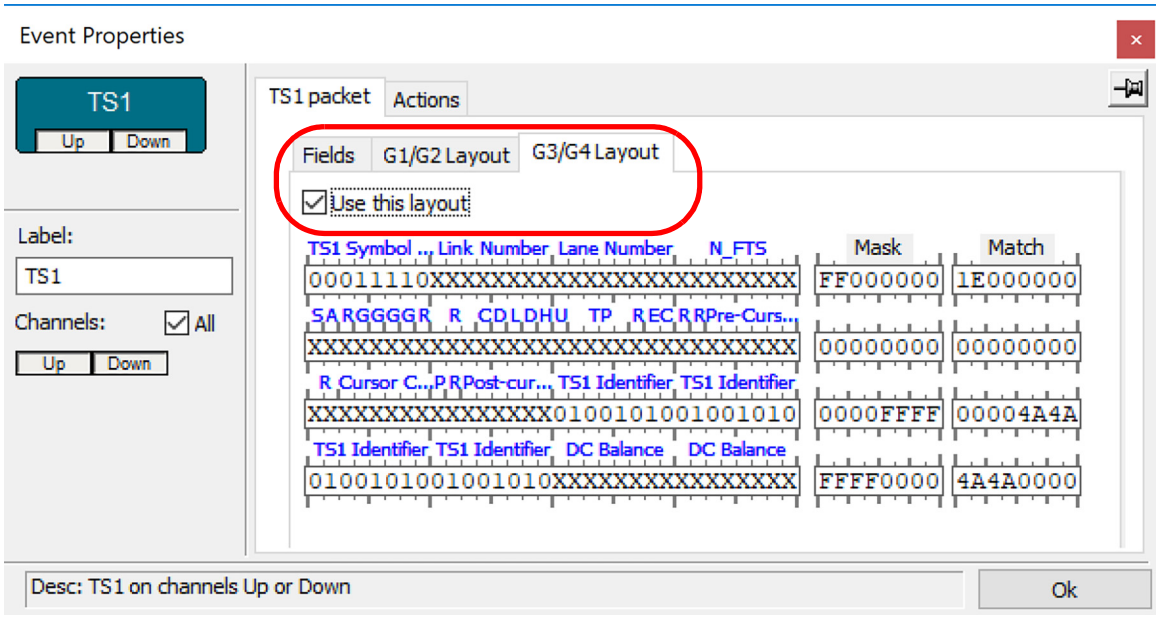


Figure 5.60: Ordered Set: TS1 -> G3/G4 Layout Options

TS1 Actions are shown in Figure 5.61 on page 293.

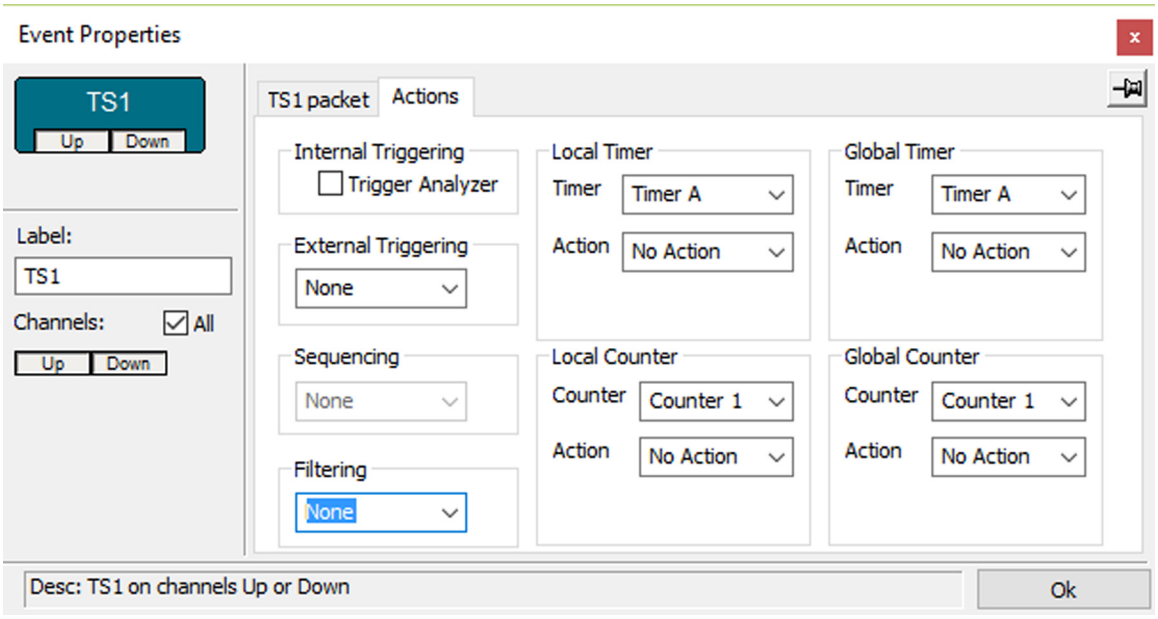


Figure 5.61: Ordered Sets: TS1 -> Actions

5.14.5.7 Compliance Set Properties Dialog

After selecting the options you want click on the “OK” button.

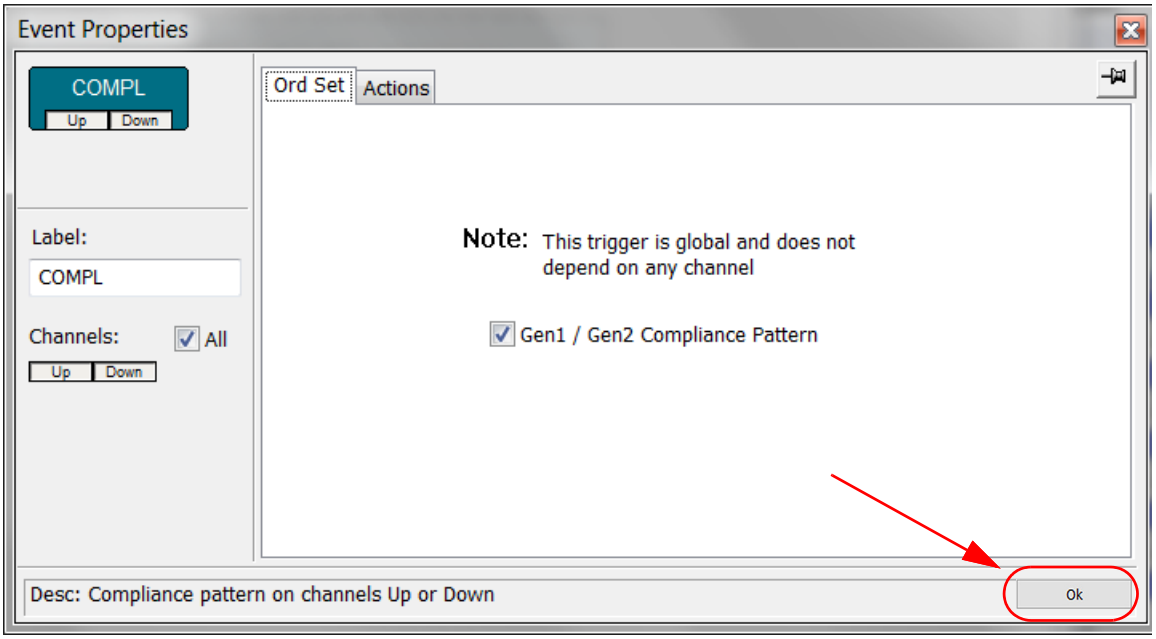


Figure 5.62: Compliance Set Properties

5.14.5.8 Error Properties Dialog

The Error Properties dialog lets you select specific error types for performing an action. There are two sets of Error types: Packet Errors and Idle Errors. After selecting the options you want click on the “OK” button.

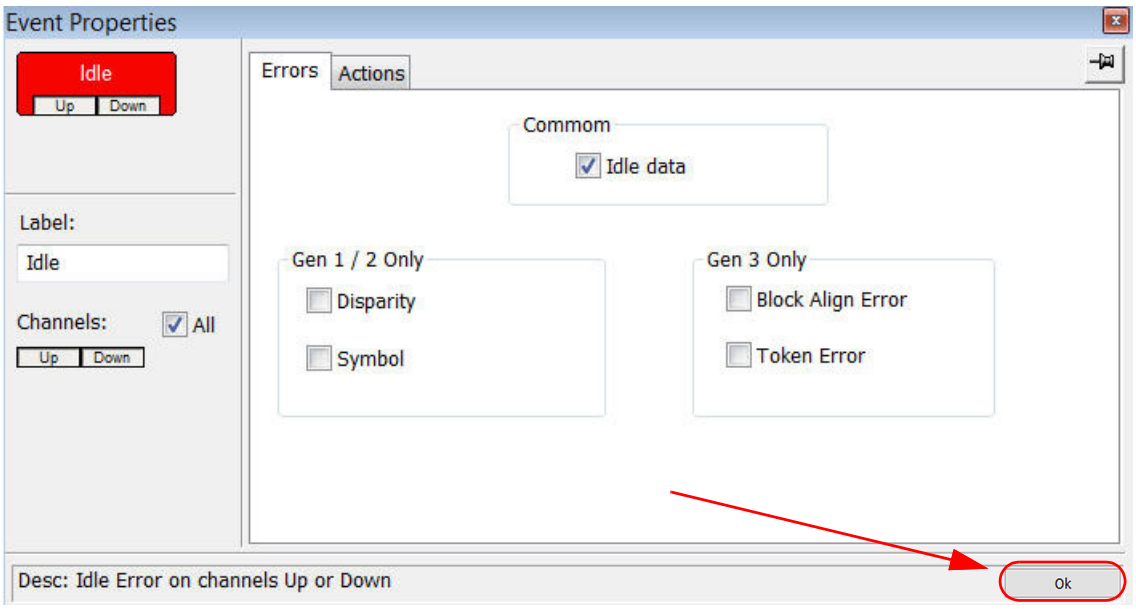


Figure 5.63: Error Properties Dialog.

5.14.5.9 DLLP Packet Properties Dialog

The DLLP Packet Properties dialog allows you to specify any DLLP field as shown below. After selecting the options you want click on the “OK” button.

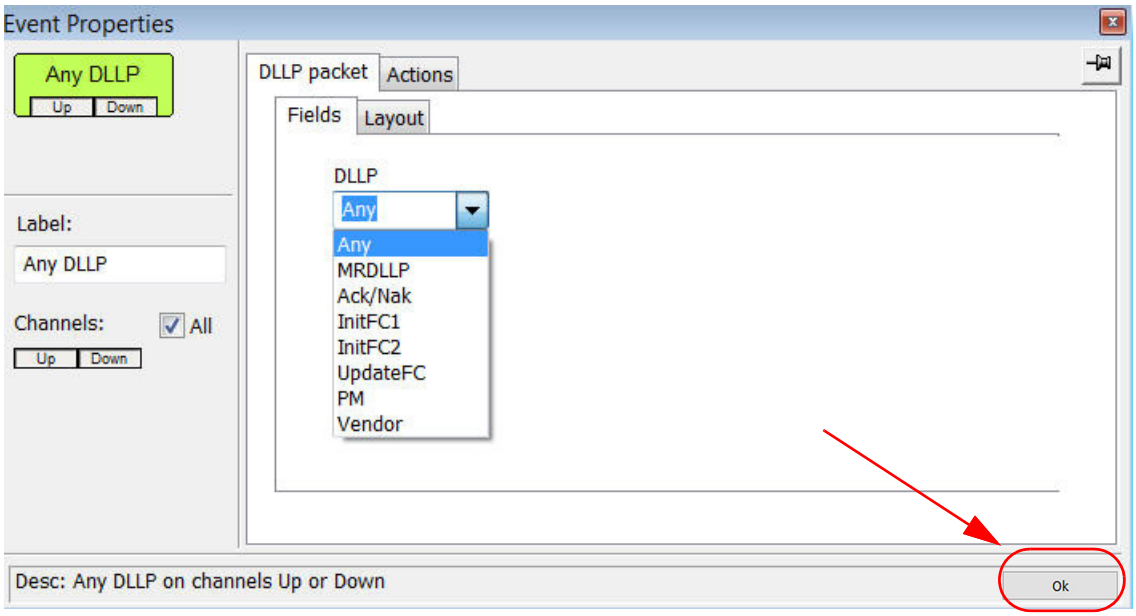


Figure 5.64: DLLP Packet Properties Dialog.

The Layout tab of the DLLP Packet Properties dialog allows you to change the pattern and customize it by defining each specific bit as shown in the figure below. After selecting the options you want click on the “OK” button.

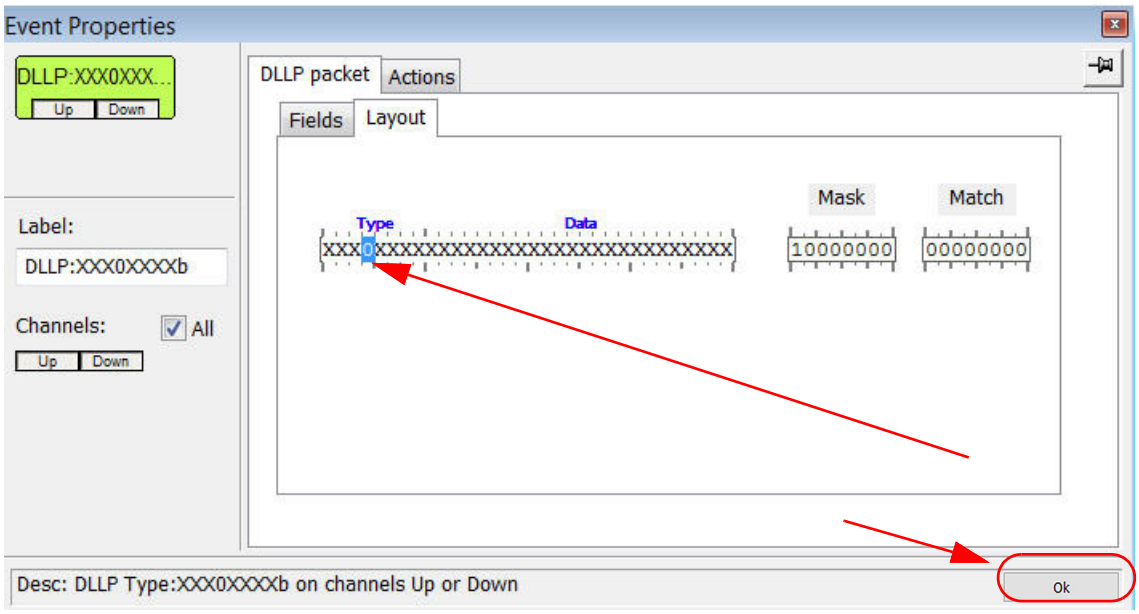


Figure 5.65: DLLP Packet Properties Dialog.

5.14.5.10 TLP Header Properties Dialog

The TLP Header Properties dialog enables you to set the TLP Header Fields and Layout, TLP Prefixes and Actions. You can manually change the Requester/Completer ID. After selecting the options you want click on the “OK” button.

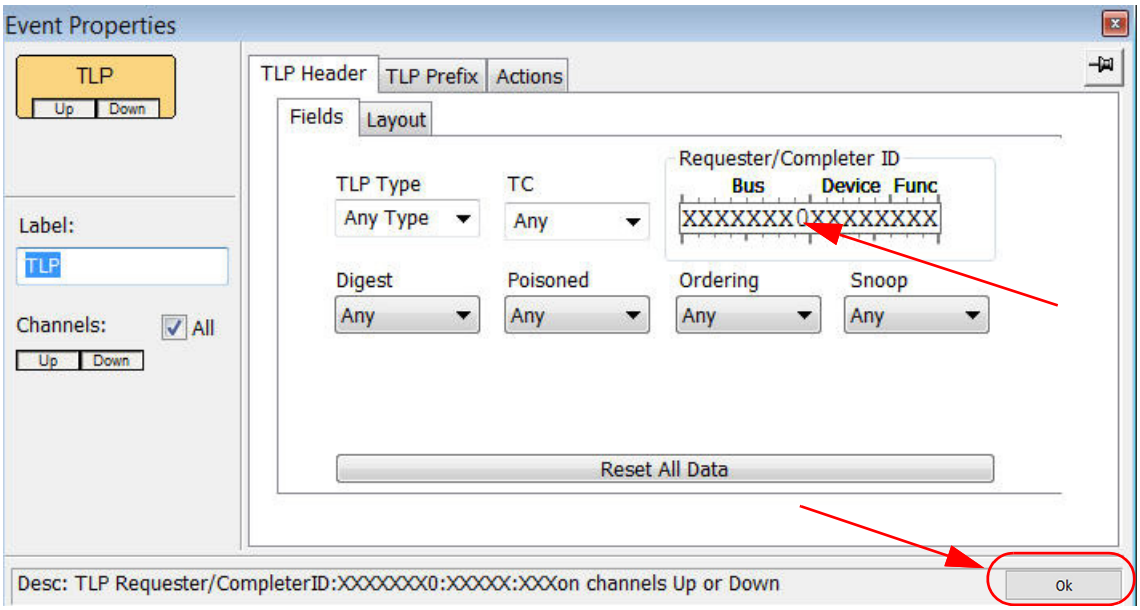


Figure 5.66: TLP Header Properties Dialog.

5.14.5.11 TLP Prefix Properties Dialog

The Layout tab of the TLP Prefix Packet Properties dialog allows you to change the pattern and customize it by defining each specific bit as shown in the figure below. After selecting the options you want click on the “OK” button.

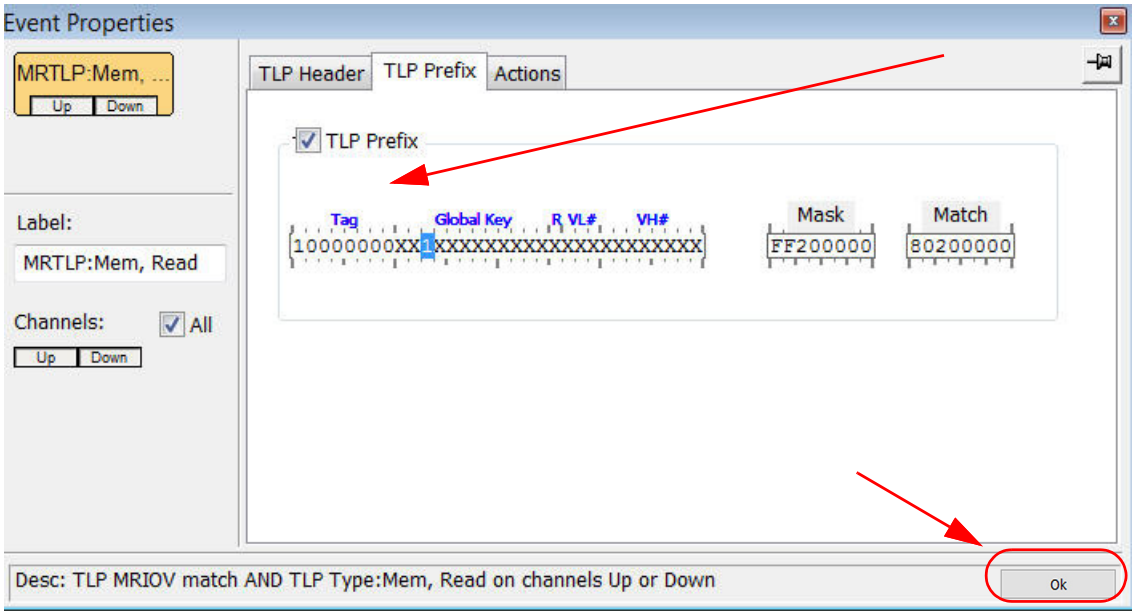


Figure 5.67: TLP Prefix Properties Dialog.

TLP: Lightweight Notification -> Message Properties Example

You can set the analyzer to trigger on a TLP Lightweight Notification Protocol Message by selecting TLP -> Message and then setting the “L” bit to 1 in the TLP Header Layout field. See Figure 5.68.

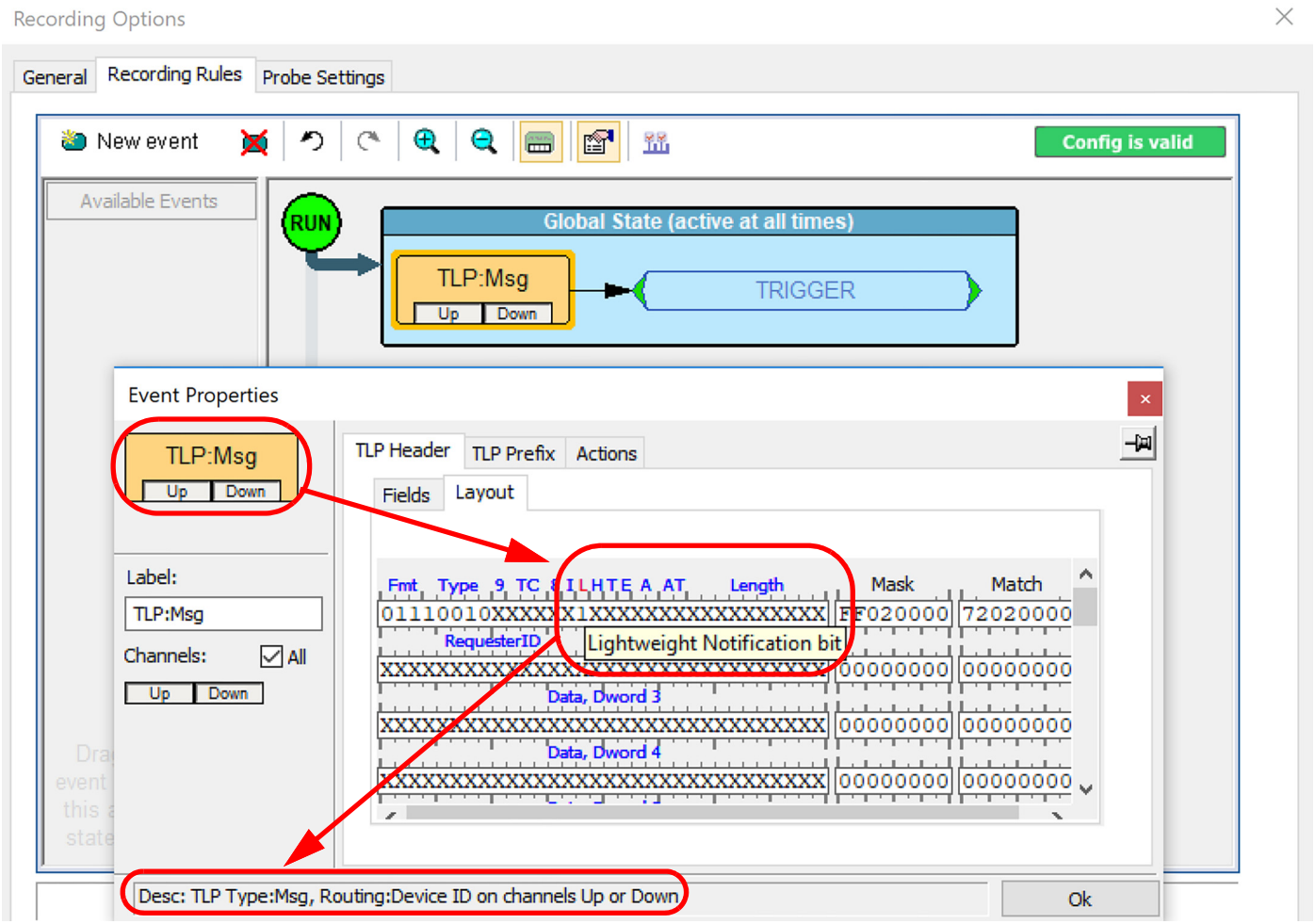


Figure 5.68: TLP: Lightweight Notification Protocol Message

TLP: Lightweight Notification -> Memory Read Example

You can set the analyzer to trigger on a TLP Lightweight Notification Protocol Memory Read by selecting TLP -> Memory Read and setting the “L” bit to 1 in the TLP Header Layout field. See Figure 5.69 on page 299.

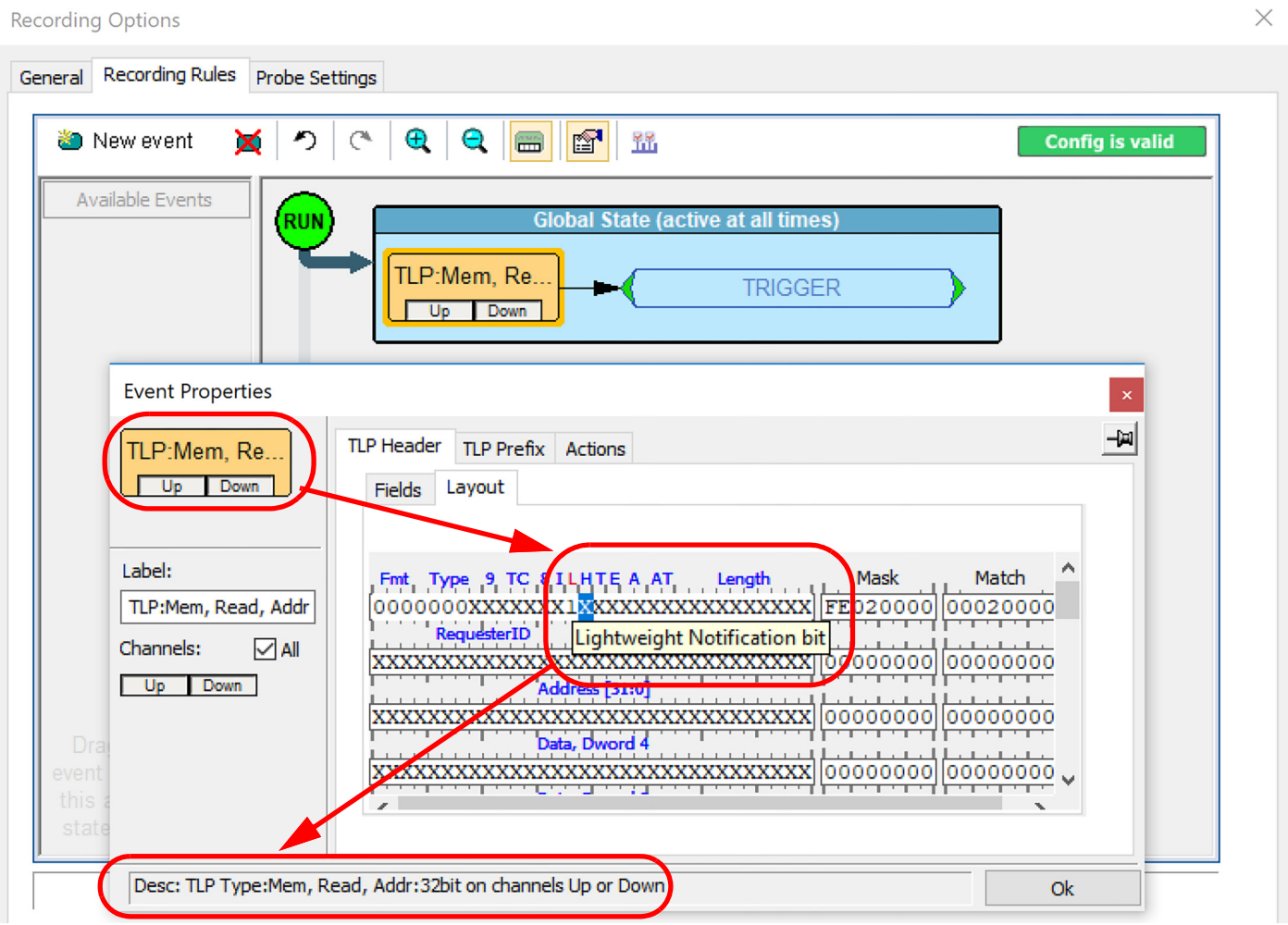


Figure 5.69: TLP: Lightweight Notification Protocol Memory Read

5.14.5.12 AHCI Register Properties Dialog

The AHCI Register Properties dialog allows you to enter the MBAR value, choose the Register and Address Type from the drop-down list and enter the offset. After selecting the options you want click on the “OK” button.

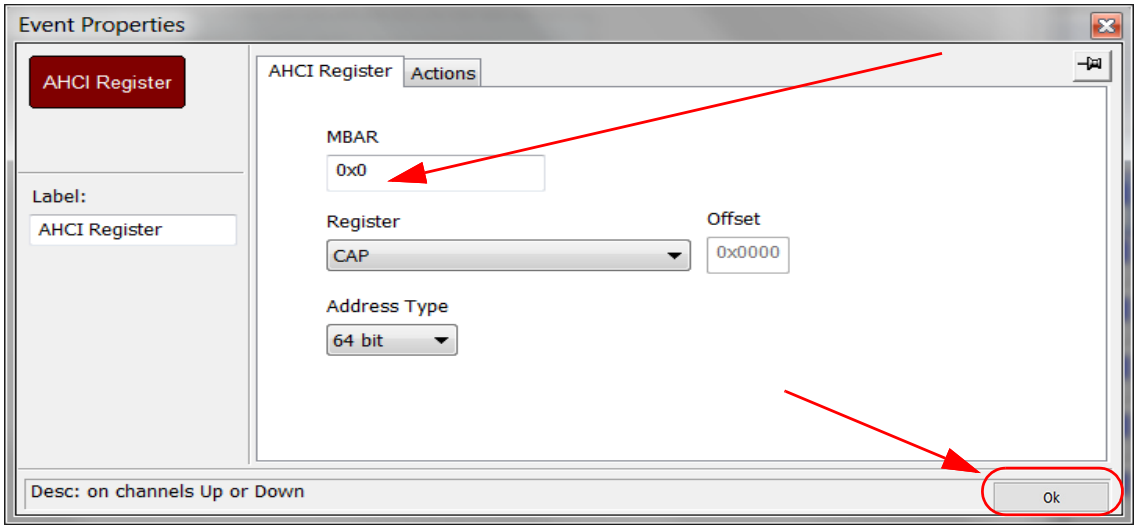


Figure 5.70: AHCI Register Properties Dialog.

Note: Triggering on register event with 32-bit address and payload defined is applicable to register write transactions only.

5.14.5.13 ATA Command Properties Dialog

The ATA Command Properties dialog allows you to change the pattern and customize it by defining each specific bit as shown in the figure below.

The data pattern can be entered directly into the field, but some fields can be selected from the drop-down list. Click on the field name for a list of available values, as illustrated in Figure 5.71. After selecting the options you want click on the “OK” button.

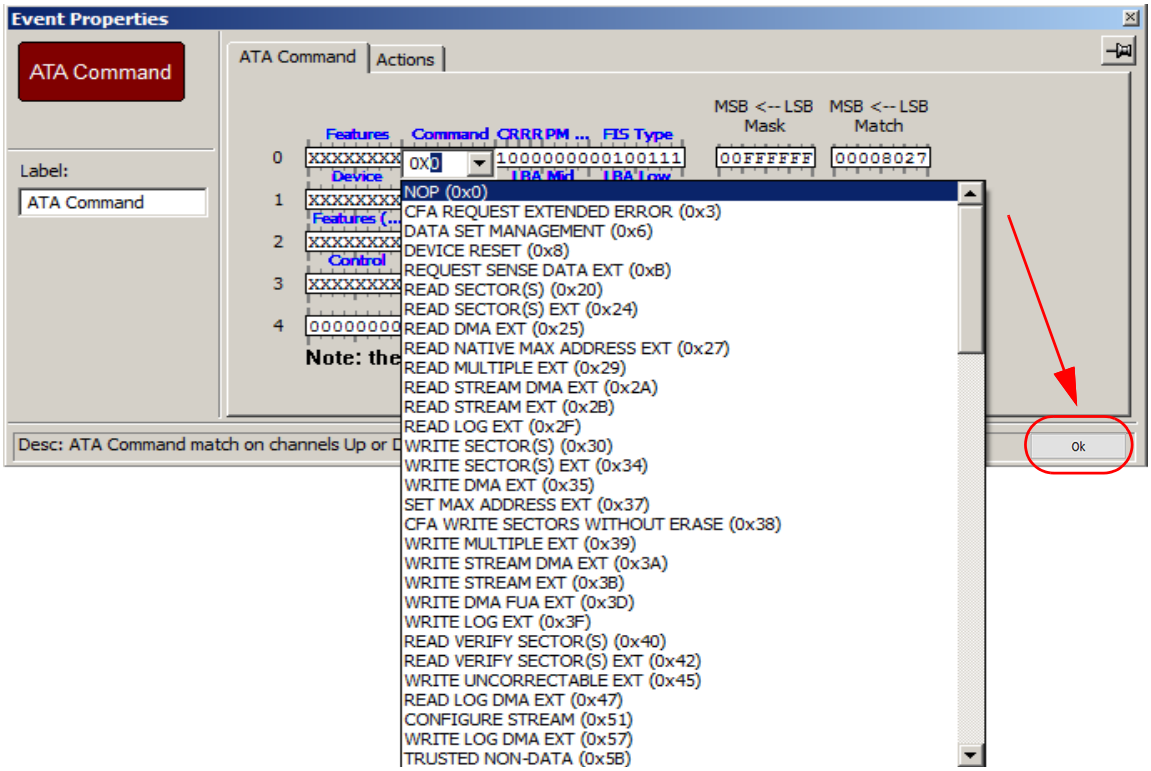


Figure 5.71: ATA Command Properties Dialog.

5.14.5.14 NVME Register Properties Dialog

Any of the NVMe Register options can be selected from the New Event list. The NVME Register options are shown in Figure 5.72.

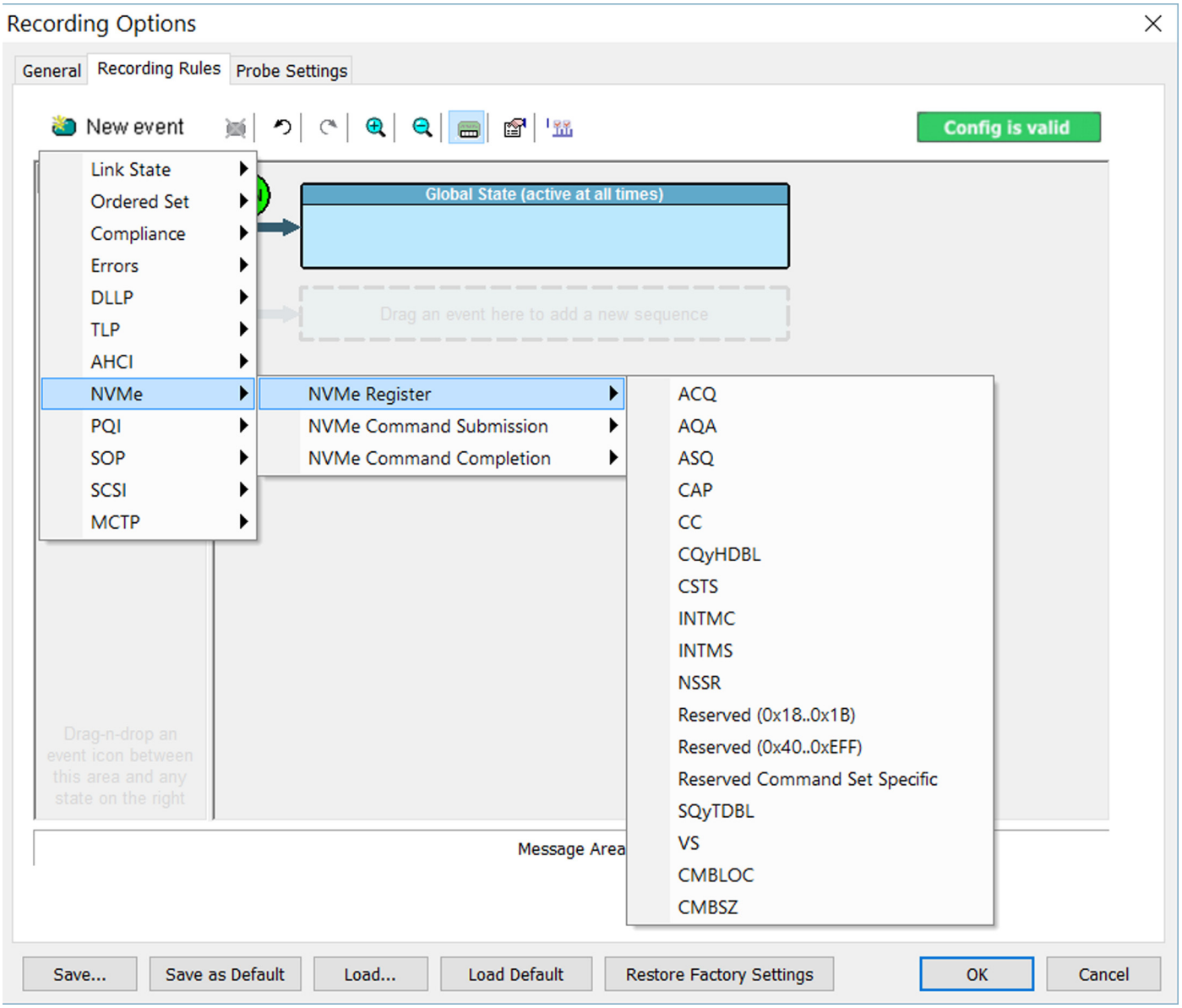


Figure 5.72: NVME Register Options Dialog

The NVME Register Properties dialog allows you to select the MBAR value, choose the Register and Address Type from the drop-down list and enter the offset. See Figure 5.73 on page 303.

The data pattern can be entered directly into the field, but some fields can be selected from the drop-down list. Click on the field name for a list of available registers as illustrated in and Figure 5.74 on page 303.

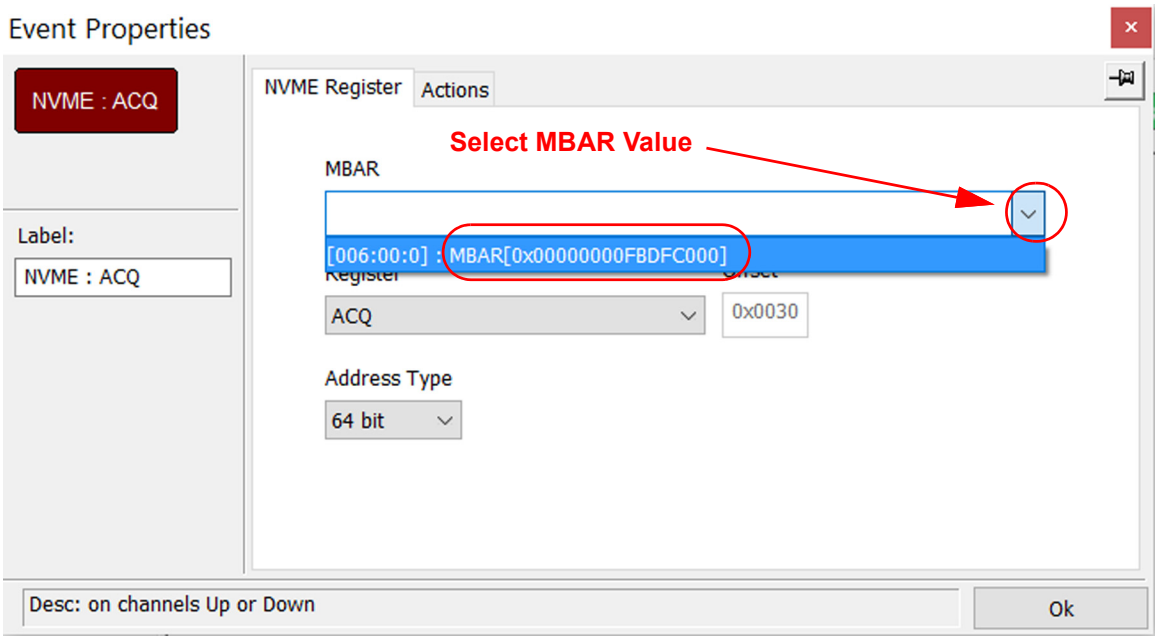


Figure 5.73: NVME Register Properties Dialog with MBAR Value Shown

Note: Triggering on register event with 32-bit address and payload defined is applicable to register write transactions only. After selecting the options you want click on the “OK” button.

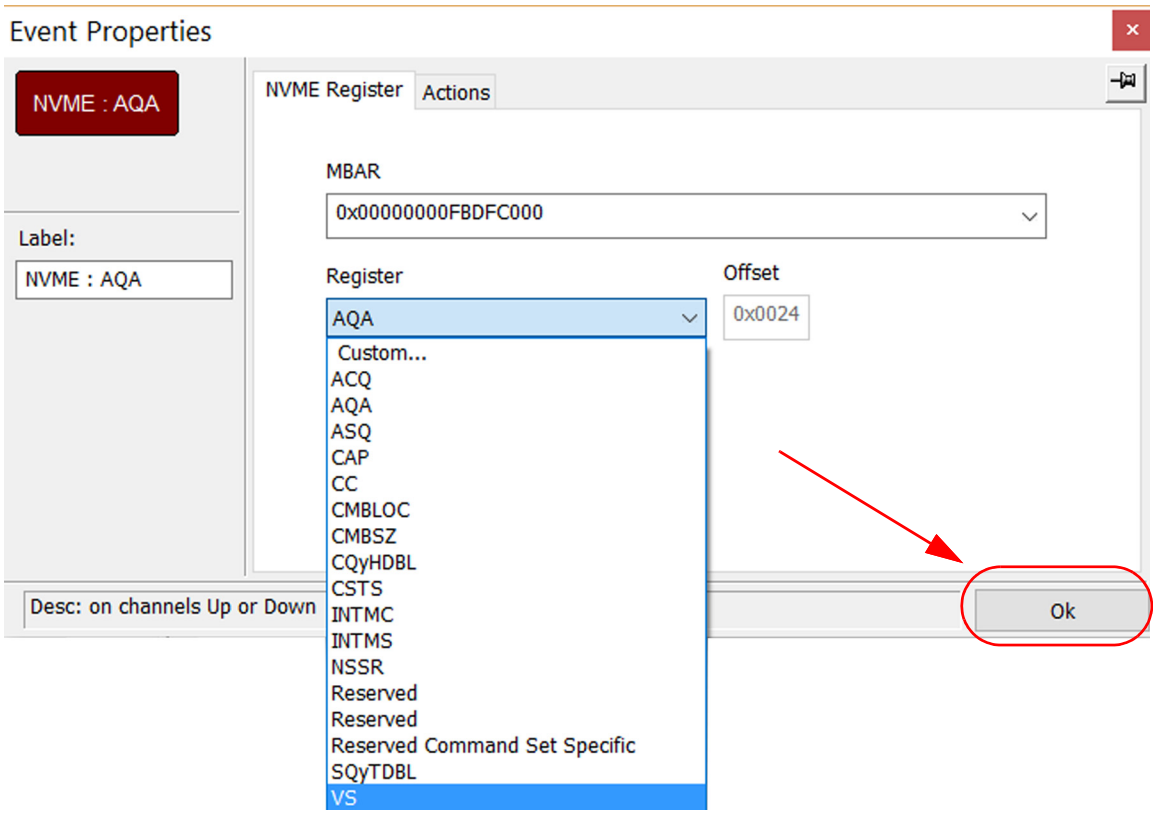


Figure 5.74: NVME Registers from Drop Down List

5.14.5.15 NVME Command Submission Properties Dialog

Any of the NVMe Command Submissions can be selected from the New Event list. The NVME Command Submission options are shown in Figure 5.75.

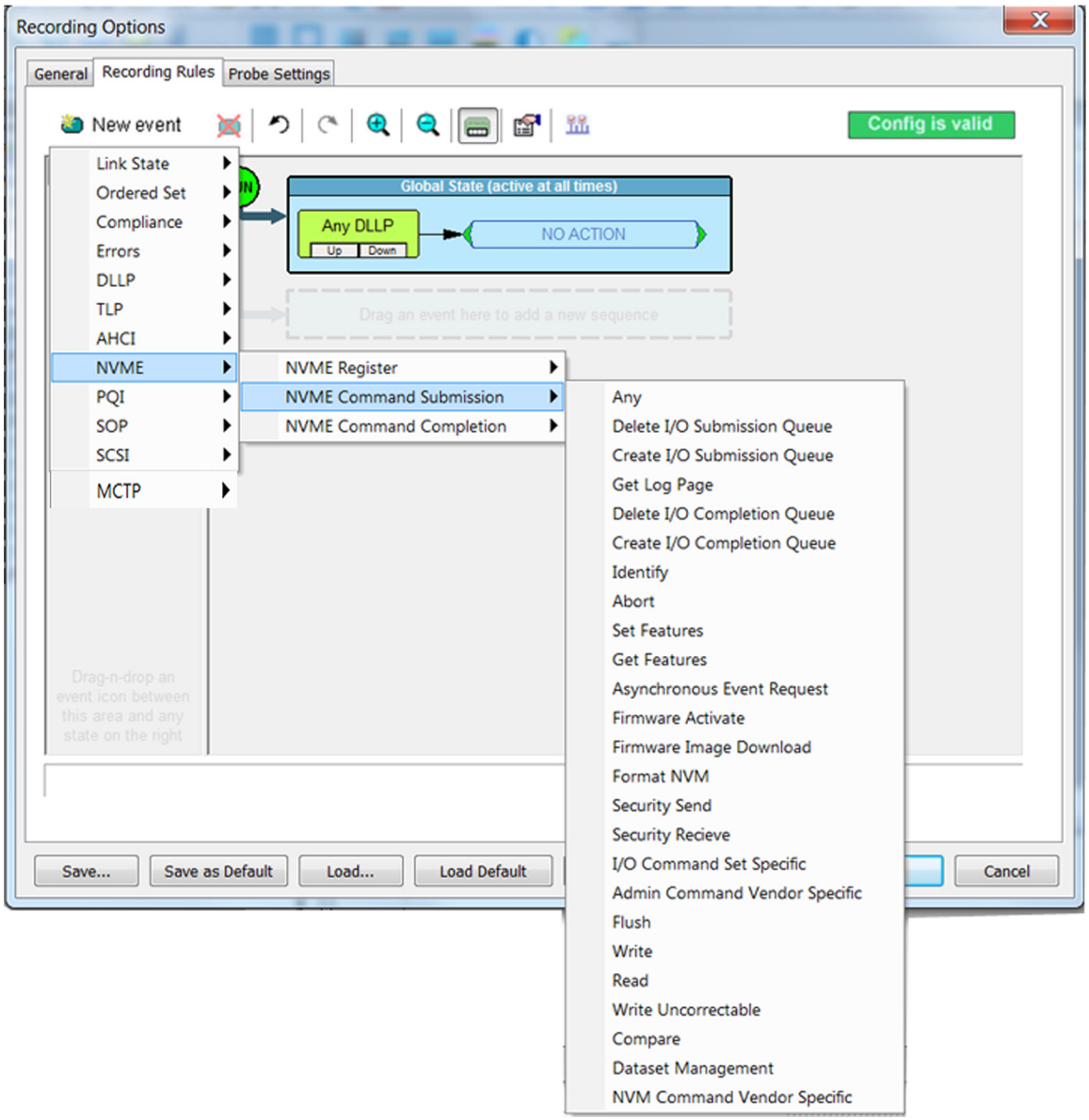


Figure 5.75: NVME Command Submission Options Dialog

The NVME Command Submission Properties dialog allows you to change the pattern and customize it by defining each specific bit.

The data pattern can be entered directly into the field, but some fields can be selected from the drop-down list. Click on the field name for a list of available values as illustrated in Figure 5.76. After selecting the options you want click on the “OK” button.

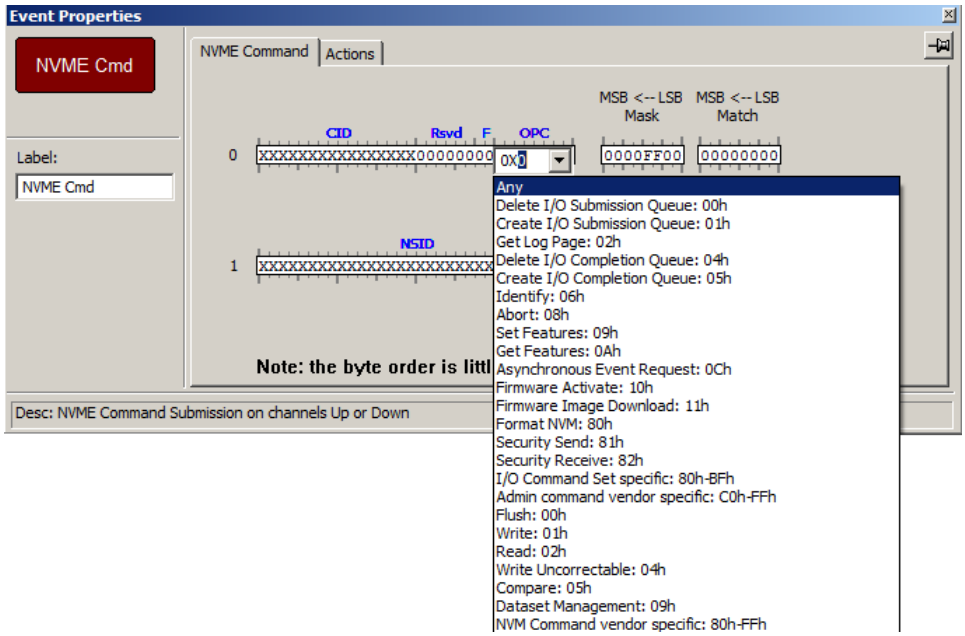


Figure 5.76: NVME Command Submission Properties Dialog.

5.14.5.16 NVME Command Completion Properties Dialog

Any of the NVMe Command Completion Options can be selected from the New Event list. The NVME Command Completion options are shown in Figure 5.77.

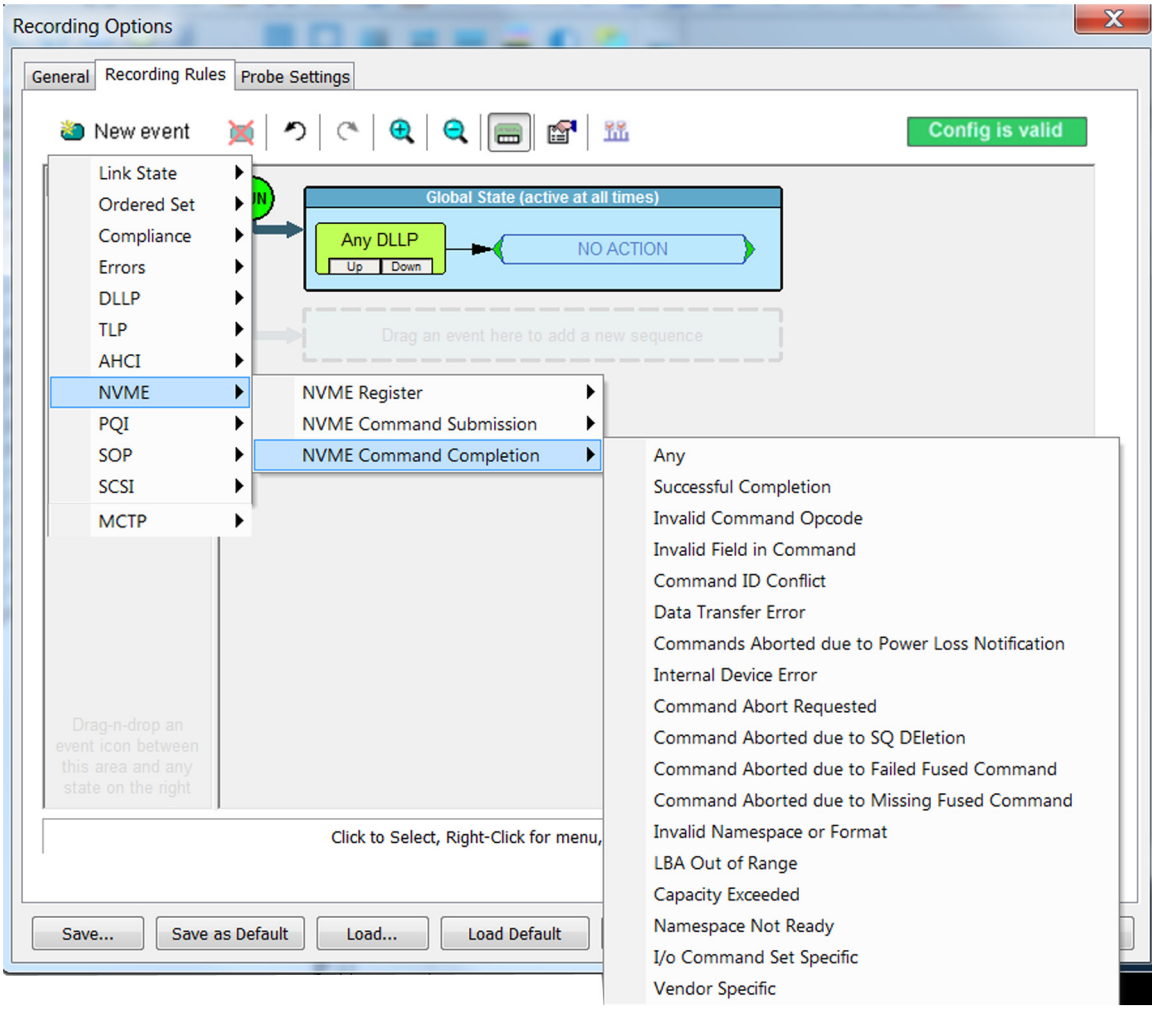


Figure 5.77: NVME Command Completion Options dialog

The NVME Command Completion Properties dialog allows you to change the pattern and customize it by defining each specific bit.

The data pattern can be entered directly into the field, but some fields can be selected from the drop-down list. Click on the field name for a list of available values as illustrated in Figure 5.78 on page 307. After selecting the options you want click on the “OK” button.

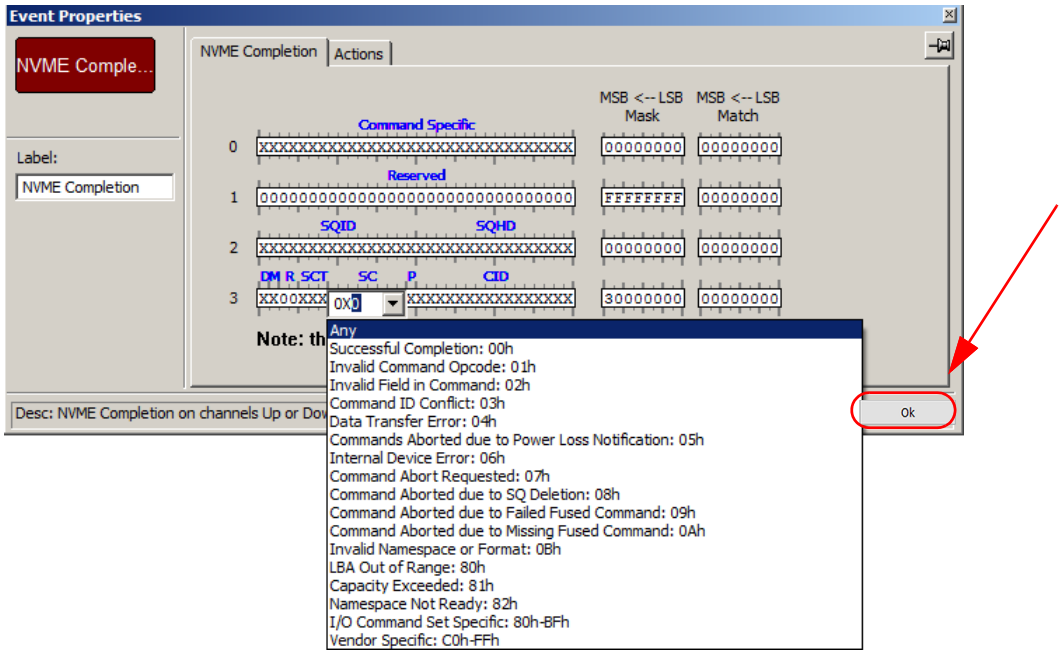


Figure 5.78: NVME Command Completion Properties Dialog.

5.14.5.17 PQI Register Properties Dialog

The PQI Register Properties dialog allows you to enter the MBAR value, choose the Register and Address Type from the drop-down list and enter the offset. After selecting the options you want click on the “OK” button.

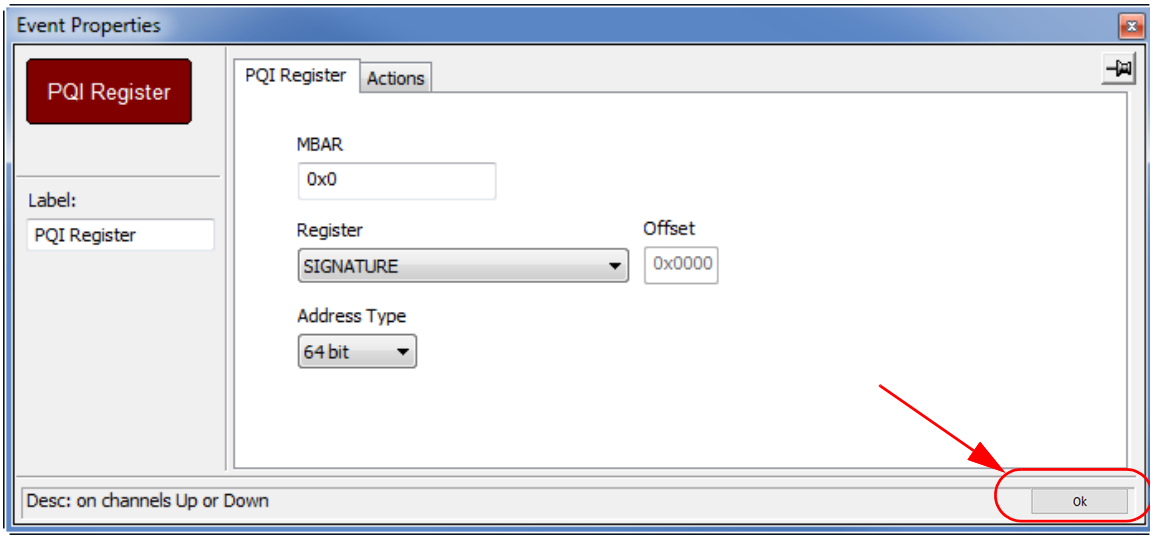


Figure 5.79: PQI Register Properties Dialog.

Note: Triggering on register event with 32-bit address and payload defined is applicable to register write transactions only.

5.14.5.18 PQI Command Properties Dialog

The PQI Command Properties dialog allows you to change the pattern and customize it by defining each specific bit.

The data pattern can be entered directly into the field, but some fields can be selected from the drop-down list. Click on the field name for a list of available values as illustrated in Figure 5.80. After selecting the options you want click on the “OK” button.

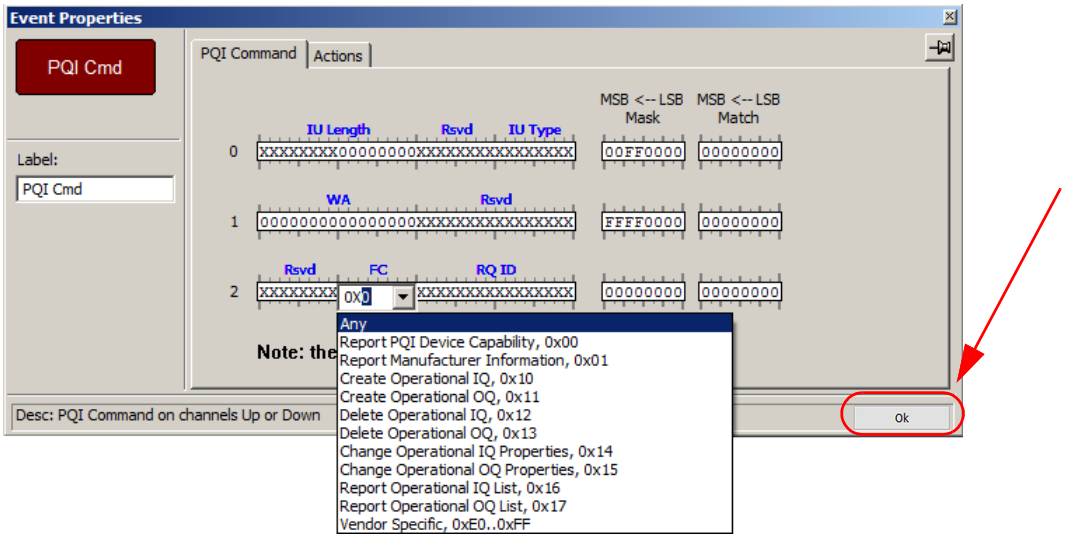


Figure 5.80: PQI Command Properties Dialog.

5.14.5.19 SOP Unit Event Properties Dialog

The SOP Unit Event Properties dialog allows you to change the pattern and customize it by defining each specific bit as shown in Figure 5.81. After selecting the options you want click on the “OK” button.

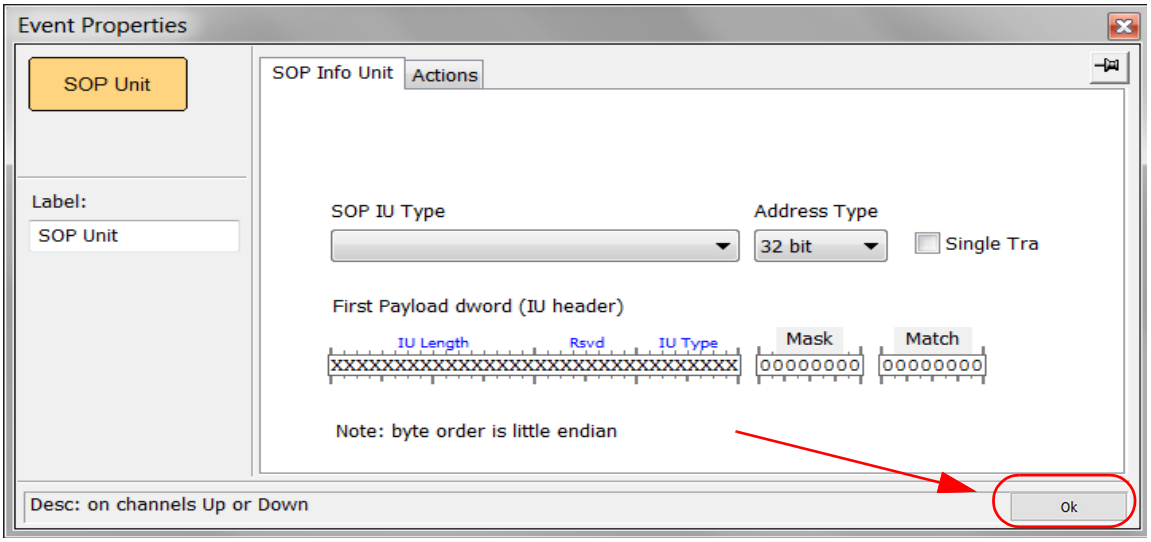


Figure 5.81: SOP Unit Event Properties Dialog.

5.14.5.20 SCSI Block Command Set Properties Dialog

The SCSI Block Command Set Properties dialog allows you to change the pattern and customize it by defining each specific bit.

The data pattern can be entered directly into the field, but some fields can be selected from the drop-down list. Click on the field name for a list of available values as illustrated in Figure 5.82. After selecting the options you want click on the “OK” button.

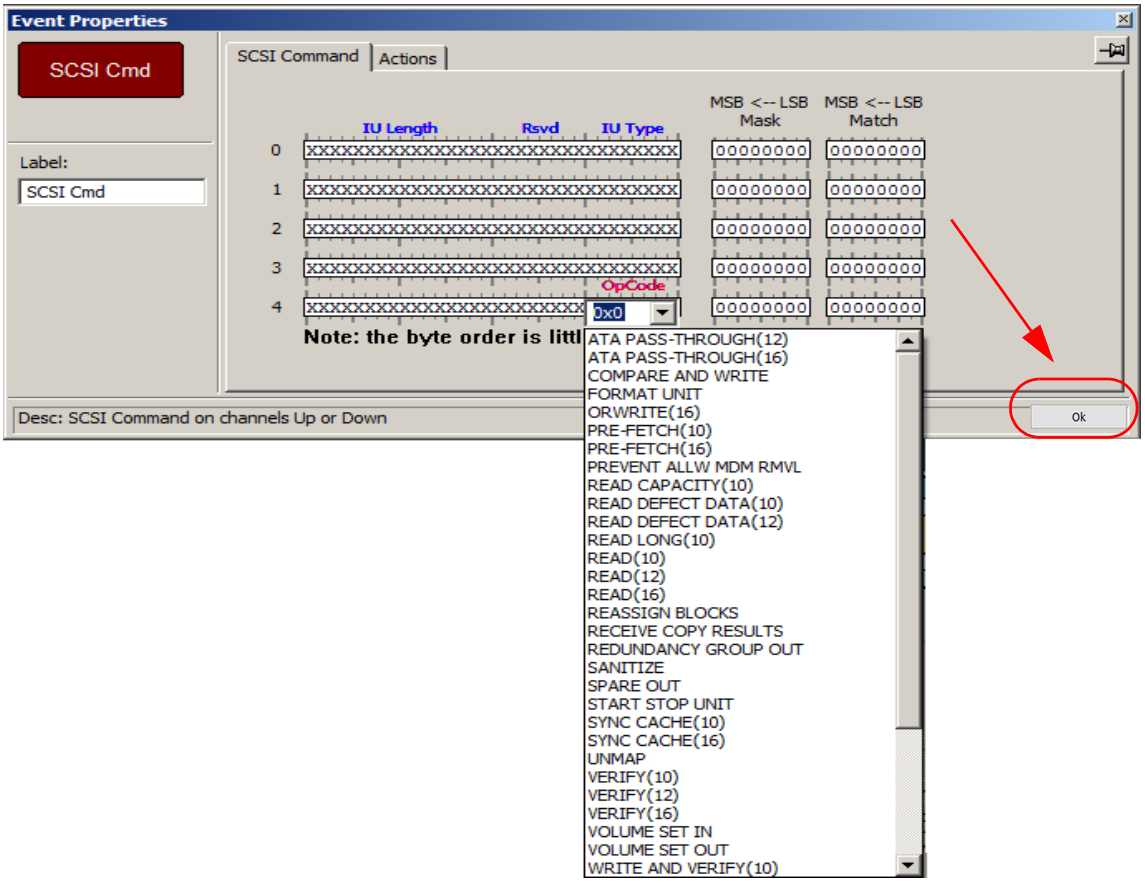


Figure 5.82: SCSI Block Command Set Properties Dialog.

The SCSI Multimedia Command Set, SCSI Media Changer Command Set, SCSI Enclosure, Services Command Set, SCSI Controller Command Set, SCSI Stream Command Set and SCSI Primary Command Set all have the same dialog as shown in Figure 5.82.

5.14.5.21 Recording Rules: MCTP New Event

You can select MCTP Packets to trigger a recording (see Figure 5.83 and Figure 5.84).

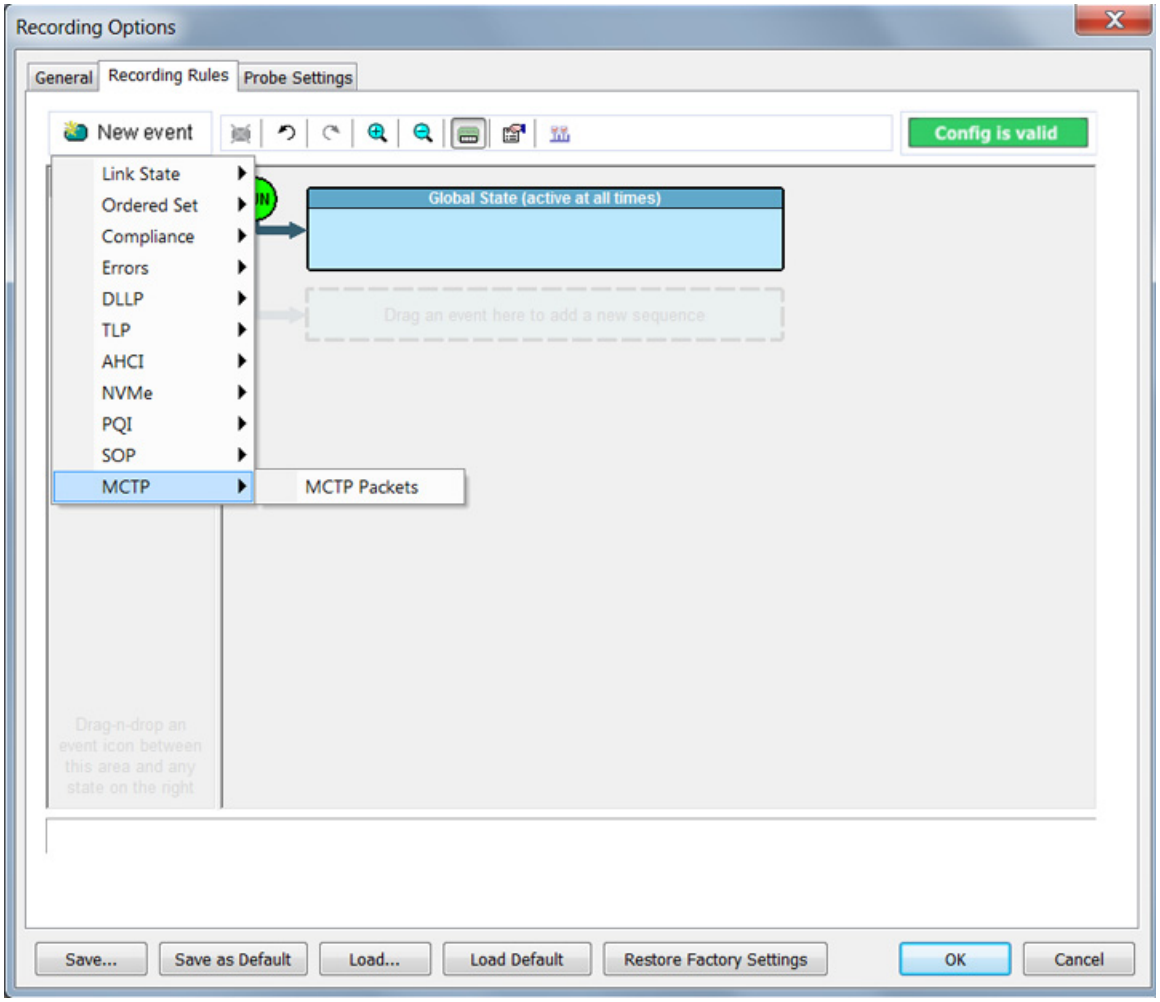


Figure 5.83: Recording Rules: MCTP New Event -> MCTP Packets

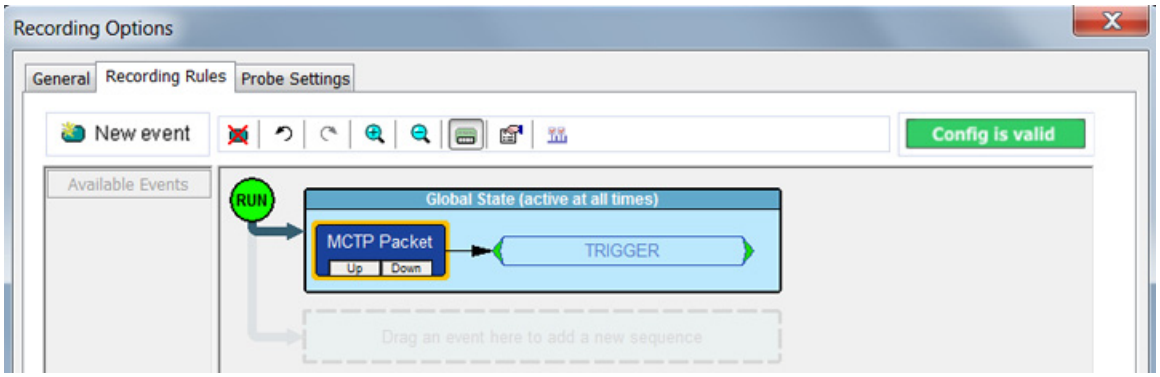


Figure 5.84: Recording Rules: MCTP Packet -> Trigger Recording

Event Properties: MCTP Packet -> Fields

The MCTP Packet Fields you can trigger on are shown in Figure 5.85. The options include Transport -> TLP VDM (Vendor Defined Message) and SMBus. After selecting the options you want click on the “OK” button.

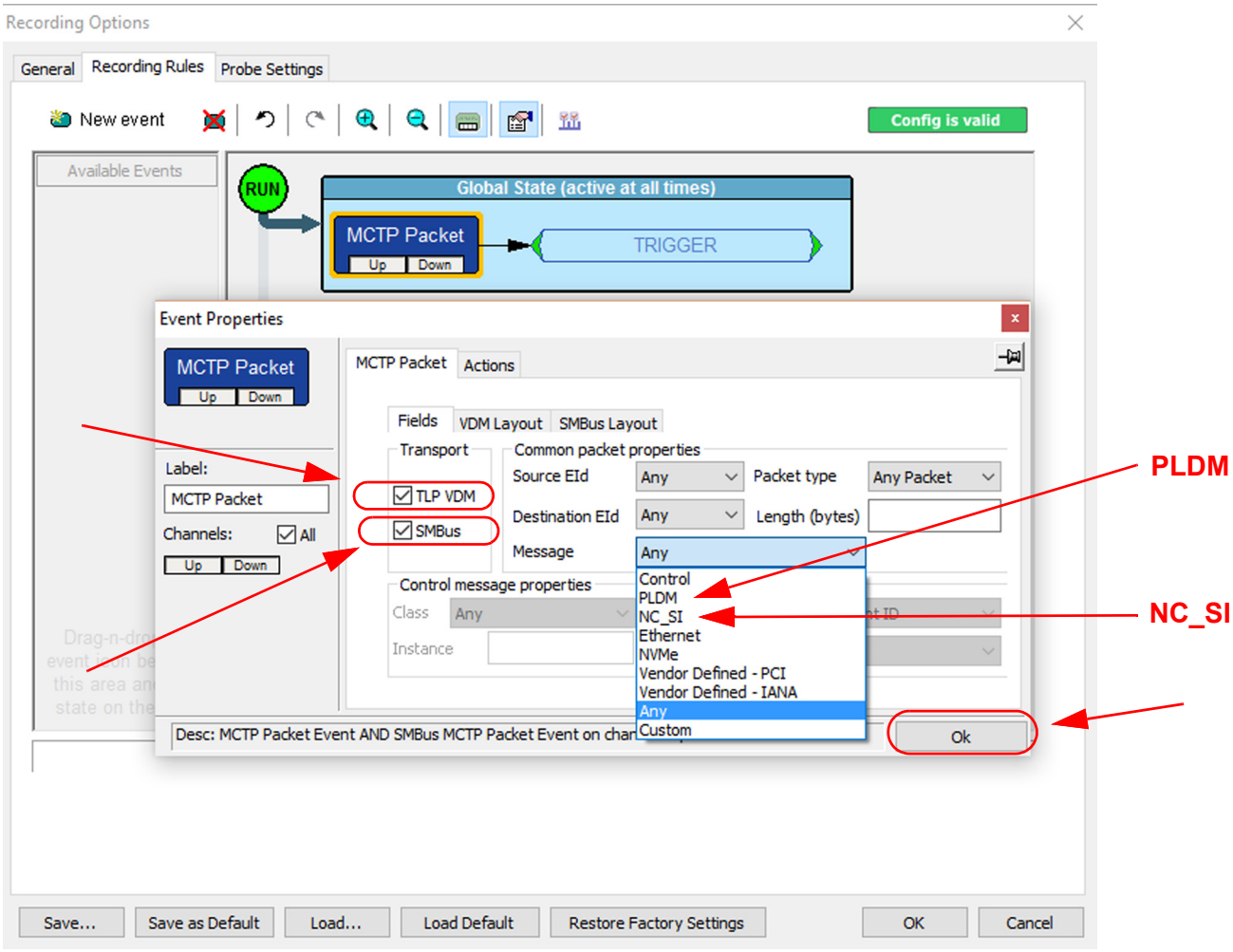


Figure 5.85: Event Properties: MCTP Packet -> Fields -> Messages

You can trigger on the following Transport types:

- TLP VDM
- SMBus

You can also trigger on the following Message Types

- Control
- PLDM
- NC_SI
- Ethernet
- NVME
- Vendor Defined - PCI
- Vendor Defined - IANA
- Any

- Custom

You can trigger on the following Packet types:

- Any Packet
- Start Packet
- Middle Packet
- End Packet
- Single Packet

Event Properties: MCTP Packet: VDM Layout

You can also trigger on MCTP Packet VDM Layout. After selecting the options you want click on the “OK” button.

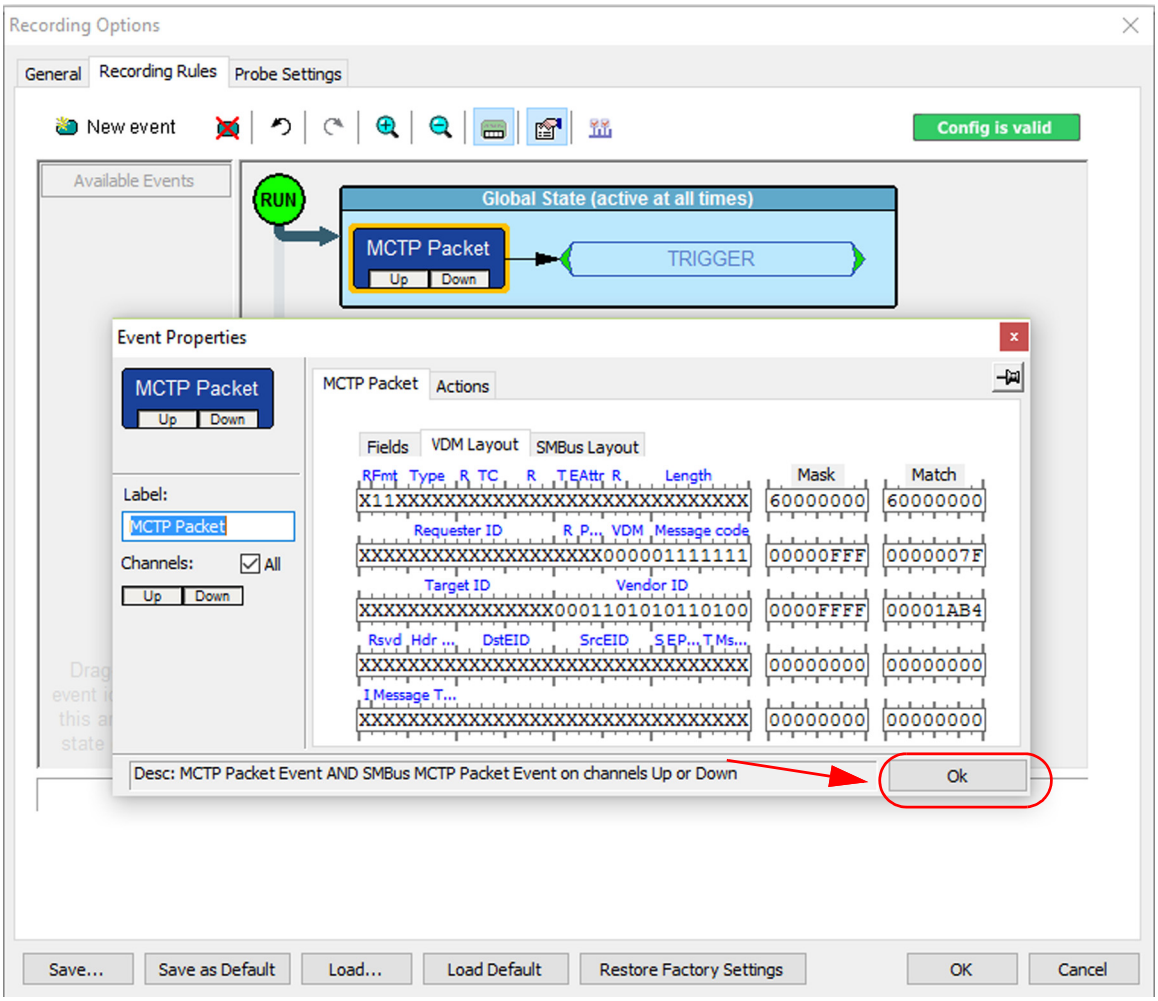


Figure 5.86: MCTP Packet: Layout Options for Trigger -> VDM Layout with Default Mask

Event Properties: MCTP Packet: SMBus Layout

You can also trigger on MCTP Packet SMBus Layout. After selecting the options you want click on the “OK” button.

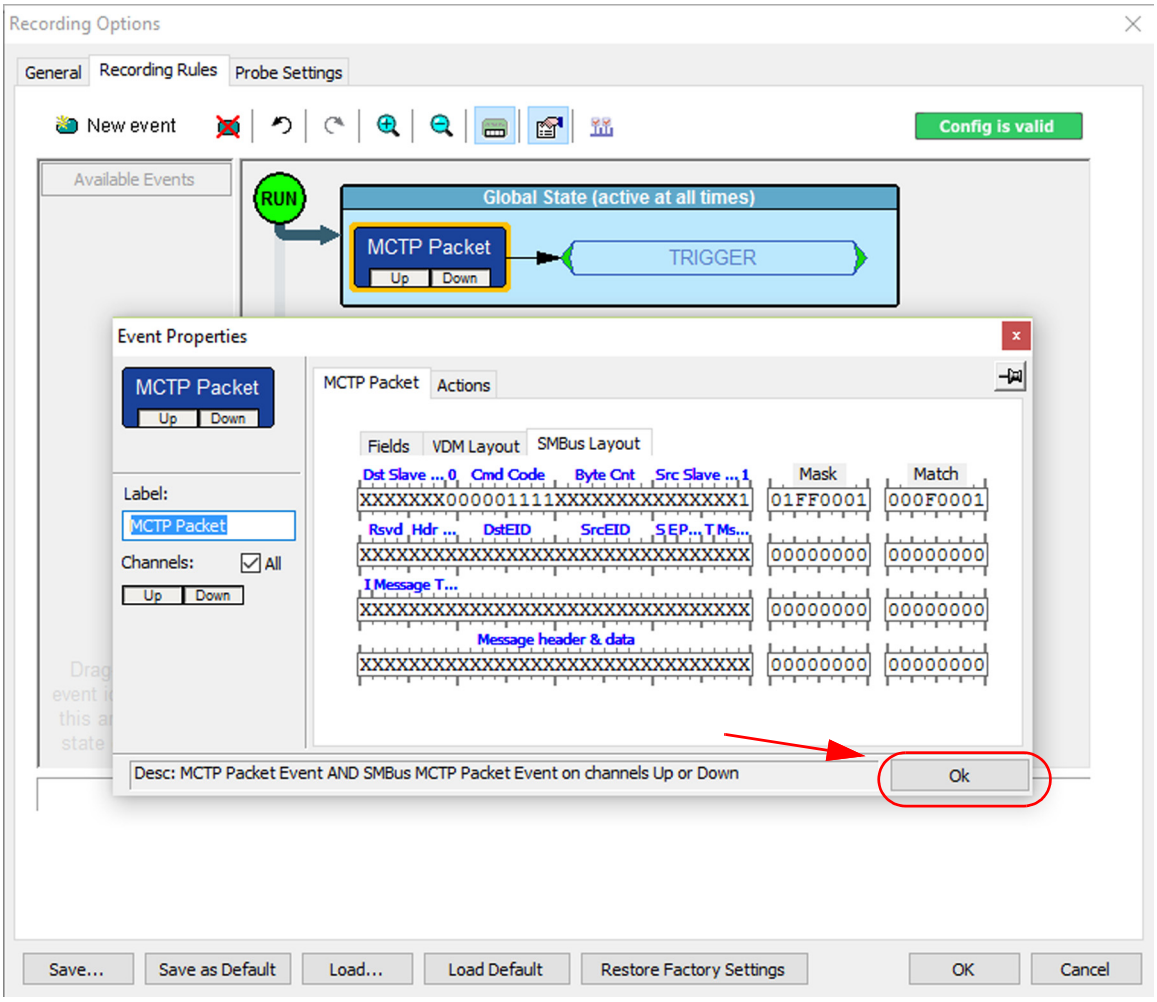


Figure 5.87: MCTP Packet: Layout Options for Trigger -> SMBus Layout with Default Mask

Event Properties: MCTP Packet -> Message: Control

If you choose MCTP Packet -> Message: Control, the Control message properties section of the GUI is enabled. See Figure 5.88.

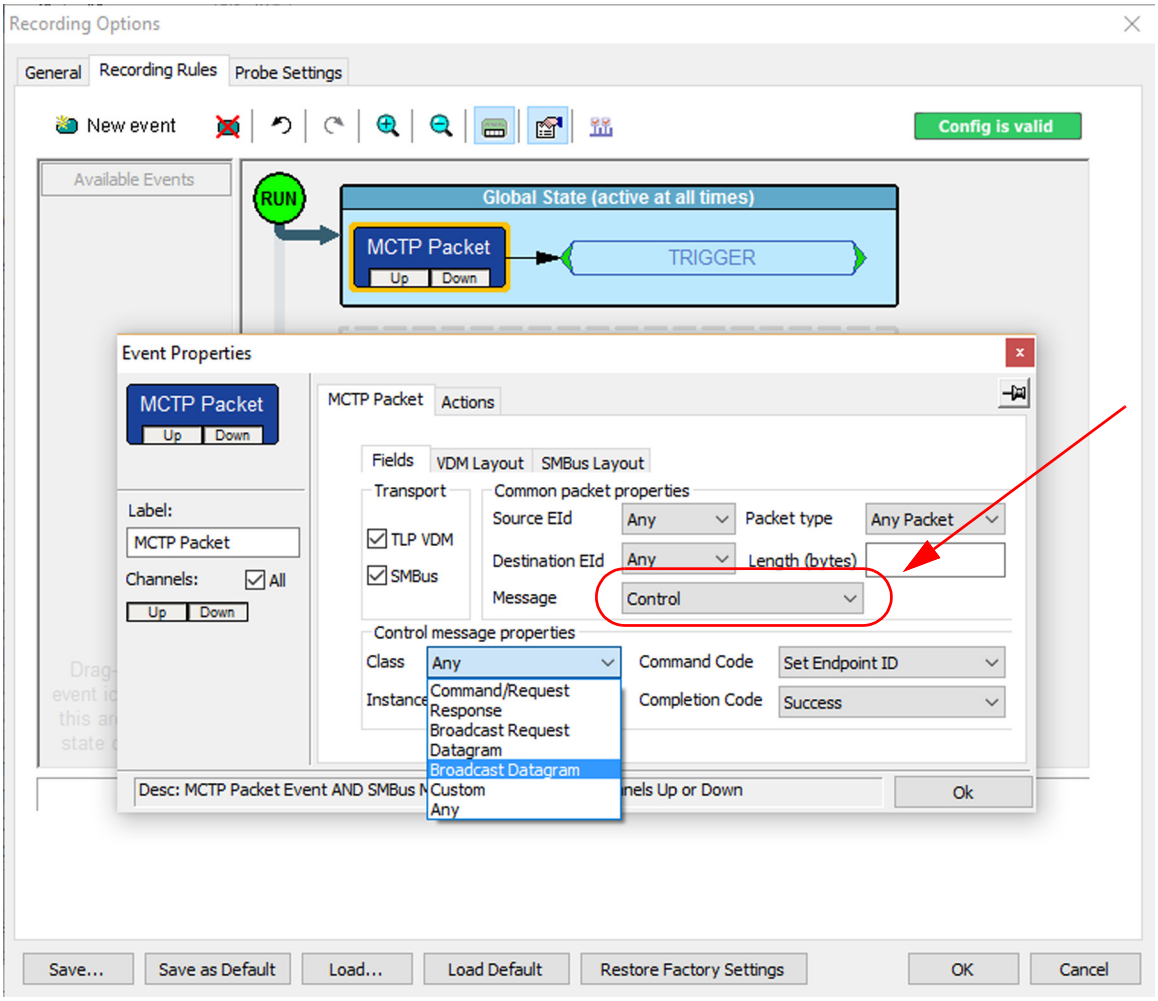


Figure 5.88: MCTP Packet -> Message: Control

MCTP Packet -> Control message properties

From this drop down dialog you can choose any of the following options to trigger on:

- Class
  - Command/Request
  - Response
  - Broadcast Request
  - Datagram
  - Broadcast Datagram
  - Custom
  - Any

There is a window for an Instance number:

- Instance (User Input)

There is also a drop down dialog for Command Codes:

- Command Codes (see Figure 5.89)

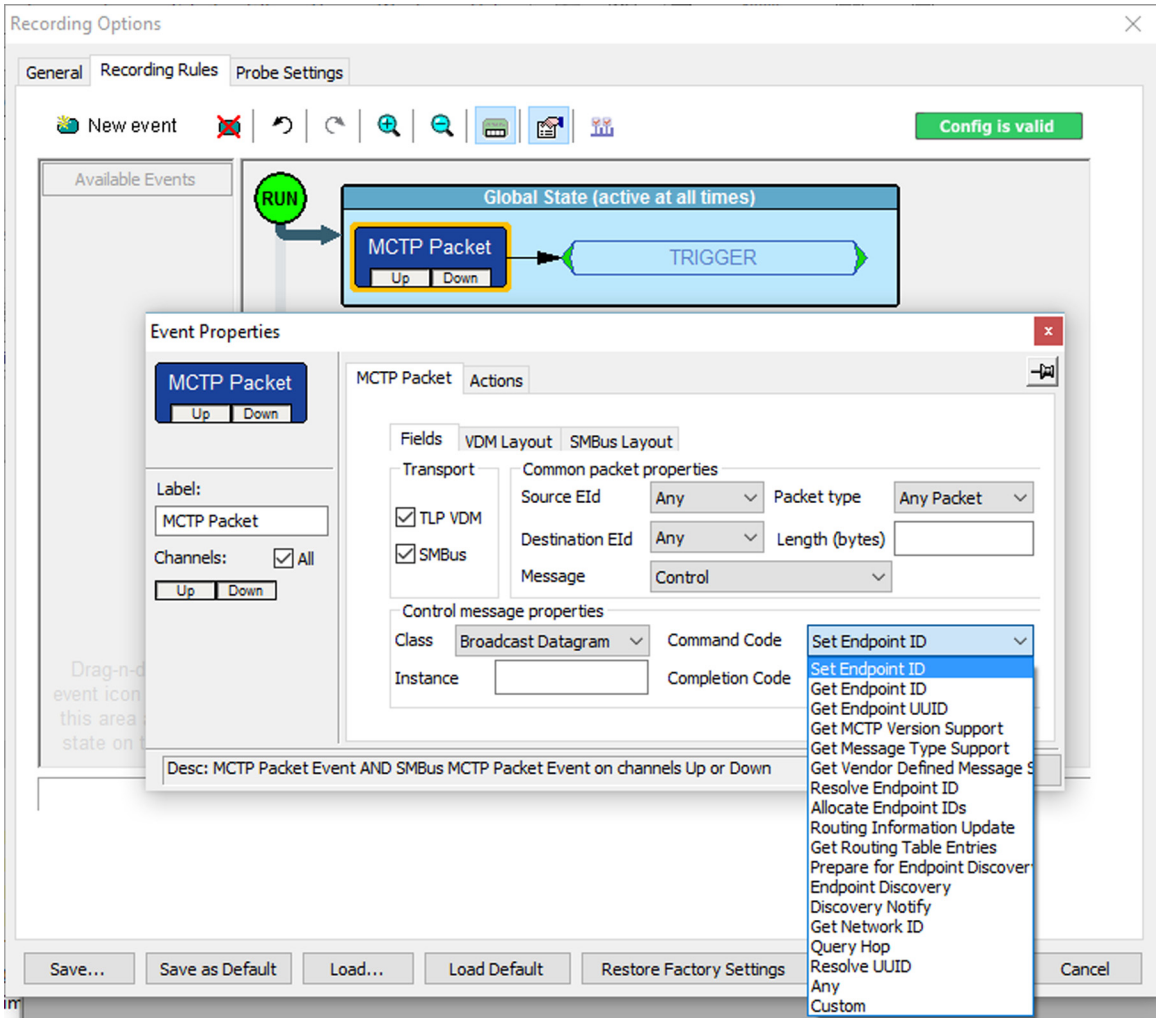


Figure 5.89: MCTP Packet -> Message: Control: Command Codes

- Set Endpoint ID
- Get Endpoint ID
- Get Endpoint UUID
- Get MCTP Version Support
- Get Message Type Support
- Get Vendor Defined Message Support
- Resolve Endpoint ID
- Allocate Endpoint IDs
- Routing Information Update
- Get Routing Table Entries
- Prepare for Endpoint Discovery
- Endpoint Discovery
- Discovery Notify
- Get Network ID
- Query Hop
- Resolve UUID
- Any
- Custom

There is also a drop down dialog for Completion Codes:

- Completion Codes (see Figure 5.90)

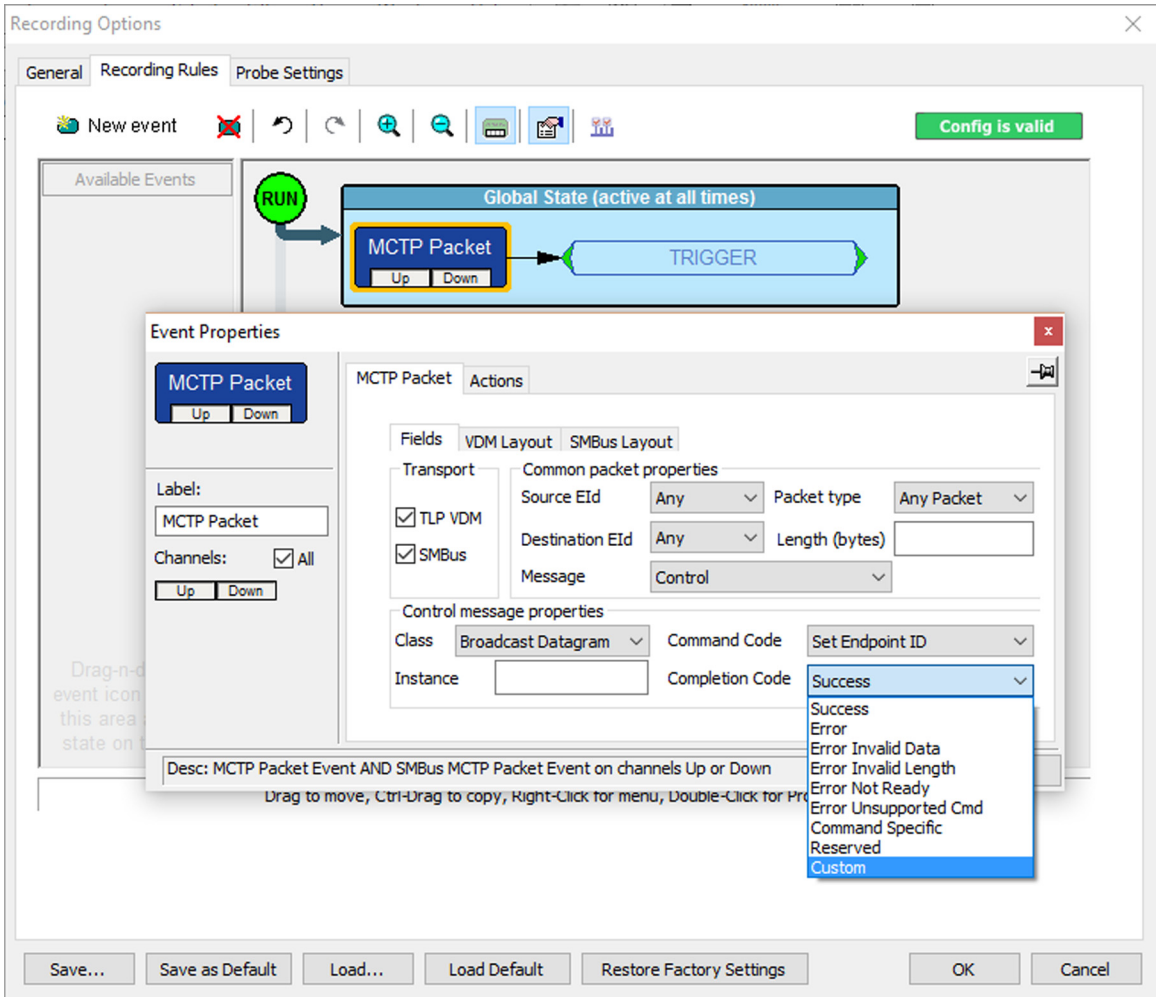


Figure 5.90: MCTP Packet -> Message: Control: Completion Codes

- Success
- Error
- Error Invalid Data
- Error Invalid Length
- Error Not Ready
- Error Unsupported Cmd
- Command Specific
- Reserved
- Custom

Event Properties: MCTP Packet -> Actions

The Actions available after triggering on an MCTP Packet are shown in Figure 5.91. After selecting the options you want click on the “OK” button.

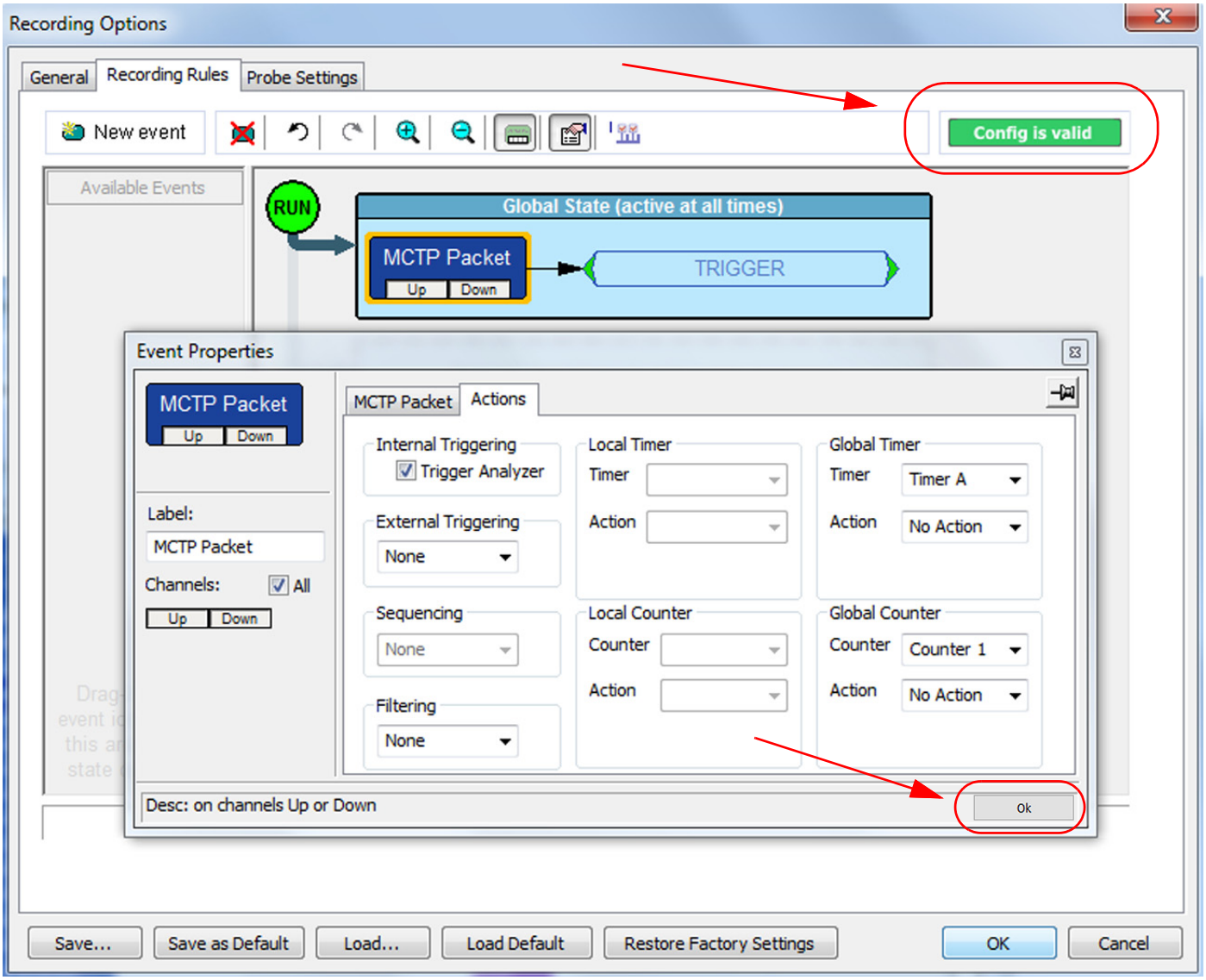


Figure 5.91: Recording Rules: MCTP Packet -> Internal Trigger: Valid

If you had attempted to choose both triggering and filtering the s/w tells you that is an Invalid triggering configuration. See Figure 5.92 on page 320.

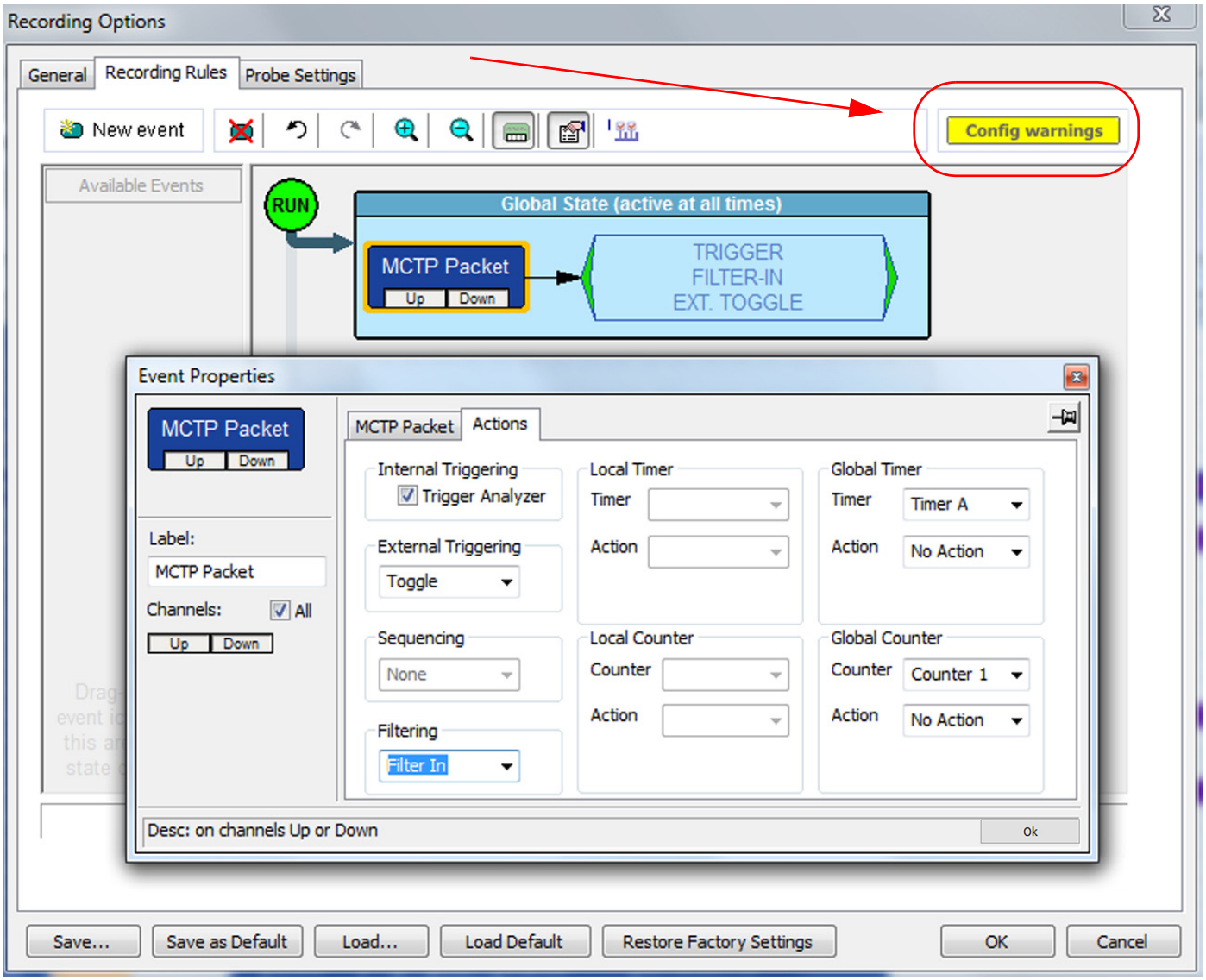


Figure 5.92: Recording Rules: MCTP Packet -> Internal Trigger and Filtering: Invalid

5.14.5.22 Actions Properties Dialog

Every Event has an Action tab as shown in Figure 5.93 on page 322.

The following tables describes the Actions for each Event.

TABLE 5.8: Event Actions

Action	Description
Label	Label the action.
Channels	Select Channels to go upstream or downstream.
Internal Triggering	Check the box to enable Internal Triggering from the Trigger In input. Any edge of the supplied signal will cause the analyzer to trigger.
External Triggering	Set the External Triggering to Low, High or Toggle. The default is None.
Sequencing	Set the Sequence to Advance. The default is None.
Filtering	Set the Filtering to Filter Out. You cannot Filter In in the Summit Z3-16. The default is None.
Local Timer	Set the Local Timer, there are four options available.
Action	You can set the Action of the timer to Start or Reset. When you reset the timer it resets to it's initial value. The default is No Action.
Local Counter	Set the Local Counter, there are four options available.
Local Counter Action	You can set the Action of the Counter to Increment or Reset. The Counter increments by one and resets to its initial value. The default is No Action.
Global Timer	Set the Global Timer, there are two options available.
Global Timer Action	You can set the Action of the timer to Start or Reset. When you reset the timer it resets to it's initial value. The default is No Action.
Global Counter	Set the Global Counter, there are two options available.
Global Counter Action	You can set the Action of the Counter to Increment or Reset. The Counter increments by one and resets to its initial value. The default is No Action.

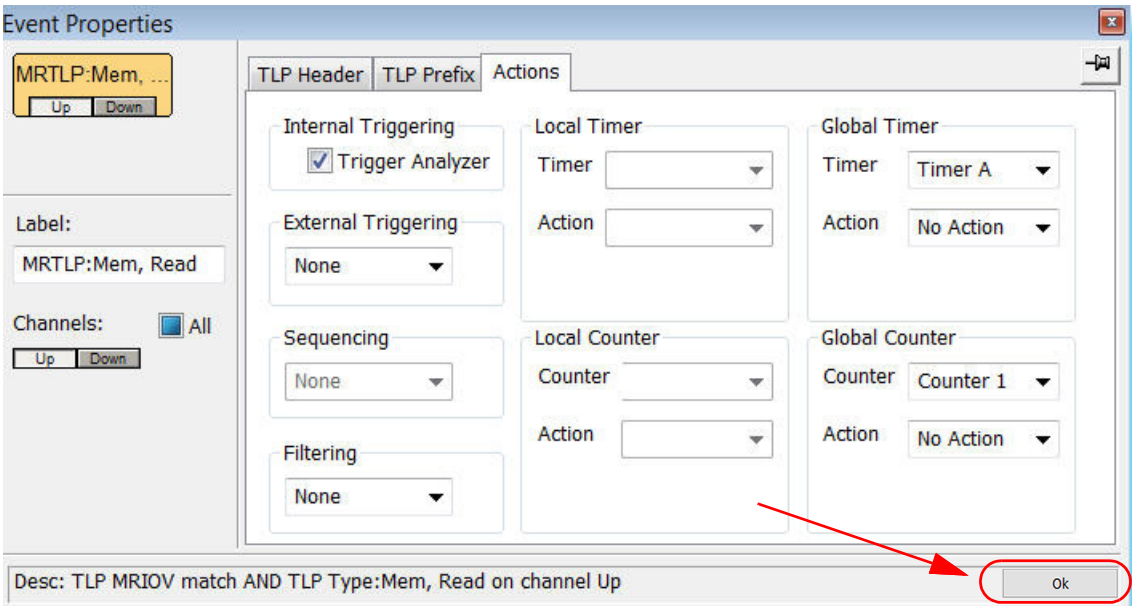


Figure 5.93: Actions Properties Dialog

5.14.6 Filter Out

A filter causes the Analyzer to filter out specified events from the recording. If events are filtered out of the recording, they are excluded from the Analyzer's buffer and not simply hidden from the CATC Trace. The purpose of “filtering out” is to preserve recording memory so you conduct longer recording sessions and exclude events that do not interest you.

5.14.6.1 Filter-Out In Simple Mode

In Simple Mode you can filter out:

- SKIP Ordered Sets
- UpdateFC DLLP
- Link Events (Link Up and Link Down)
- CLKREQ#
- WAKE#
- PERST#
- Gen1 / Gen2 compliance

You can also choose to Ignore EDS and Idle Errors. See Figure 5.94.

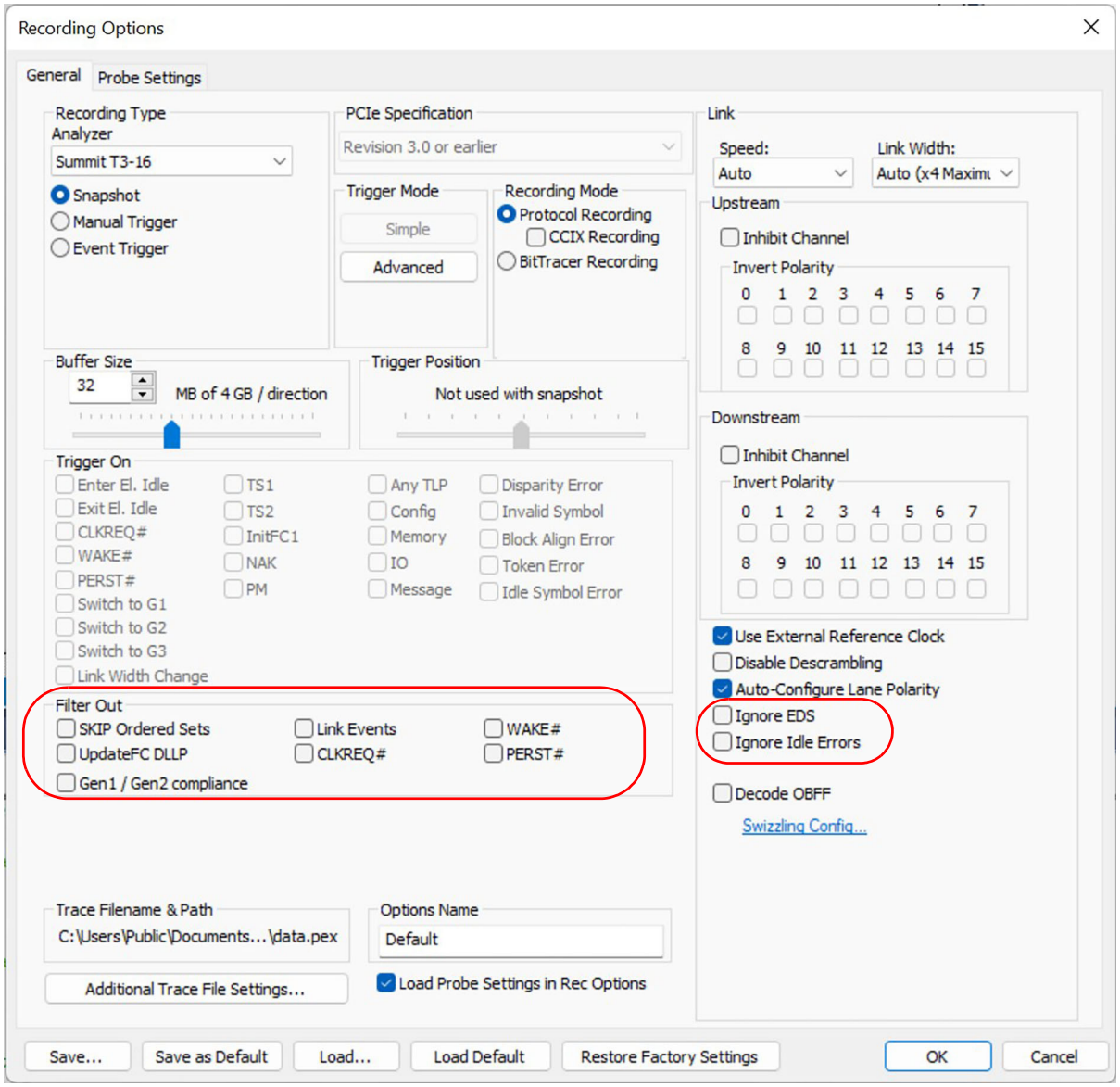


Figure 5.94: Simple Mode: Filter Out -> T3-16

Note: If you did Filter-Out all the events shown above, you'd create an empty trace and get a warning message (see "Empty Trace File Warning: If you've chosen recording conditions which result in an empty trace (no traffic is recorded), a warning message is displayed." on page 576.)

5.14.6.2 Filter-Out in Advanced Mode

To enable “filter-out” in Advanced Mode, place an event button into either the **Global State** cell or the **Sequence** cell, then right-click the button and choose an **Action** (see previous topic).

From the sub-menu, select **Filter-Out.** See Figure 5.95.

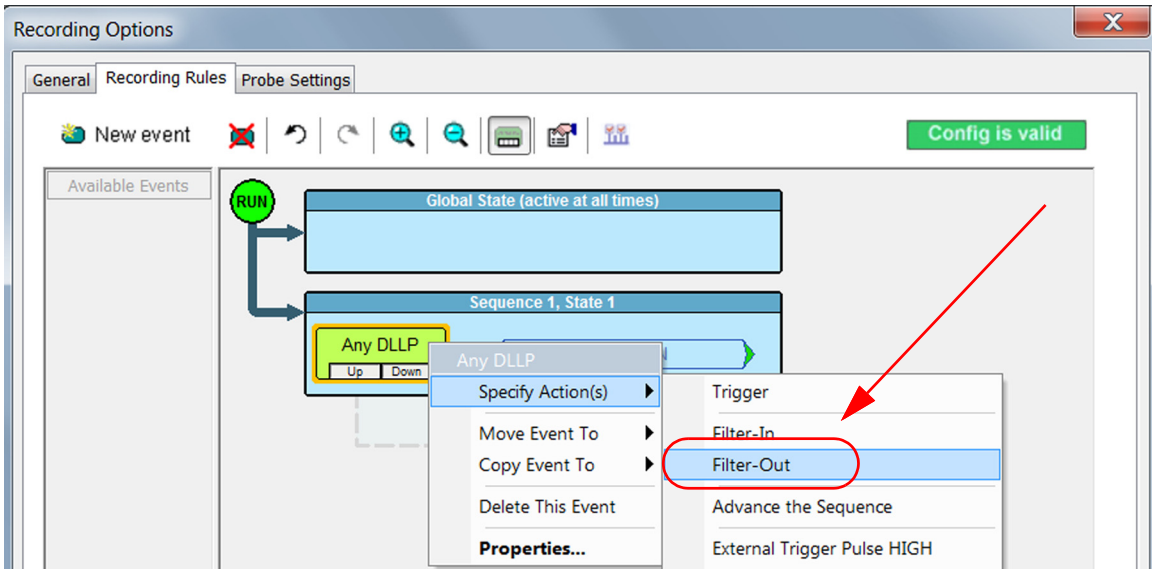


Figure 5.95: Filter Out Option

Note: The Filter-Out option is only available in the DLLP, TLP, TS1 and TS2 Ordered Sets, for Link Events Enter/Exit Electrical Idle, WAKE# Asserted/Deasserted, or CLKREQ# Asserted/Deasserted.

Note: If you did Filter-Out all events (by mistake), you’d create an empty trace and get a warning message (see “Empty Trace File Warning: If you’ve chosen recording conditions which result in an empty trace (no traffic is recorded), a warning message is displayed.” on page 576.)

5.14.7 Filter In

“Filter in” is the logical opposite of “Filter Out”. In this case, you are specifically interested in capturing specific events or traffic and ignoring everything else. If events are filtered in to the recording, they are included in the Analyzer's buffer. The purpose of “filtering in” is to preserve recording memory so you conduct longer recording sessions and include only events that interest you. Filter -n is only available in Advanced Mode.

As an example, let’s say you want to capture **Any DLLP** and **Any NVMe:ACQ** Commands.

First switch to **Advanced Mode**.

To enable “Filter-In” place an event button (DLLP -> Any DLLP) into the **Global State** cell, then right-click the button and choose an **Action**. From the sub-menu select **Filter-In.**

Then select NVMe under New Event and NVMe Register:ACQ and place that event into

the **Sequence 1, State 1** cell. Then right-click the button and choose an **Action**. From the sub-menu select **Filter-In.** See Figure 5.97 on page 326.

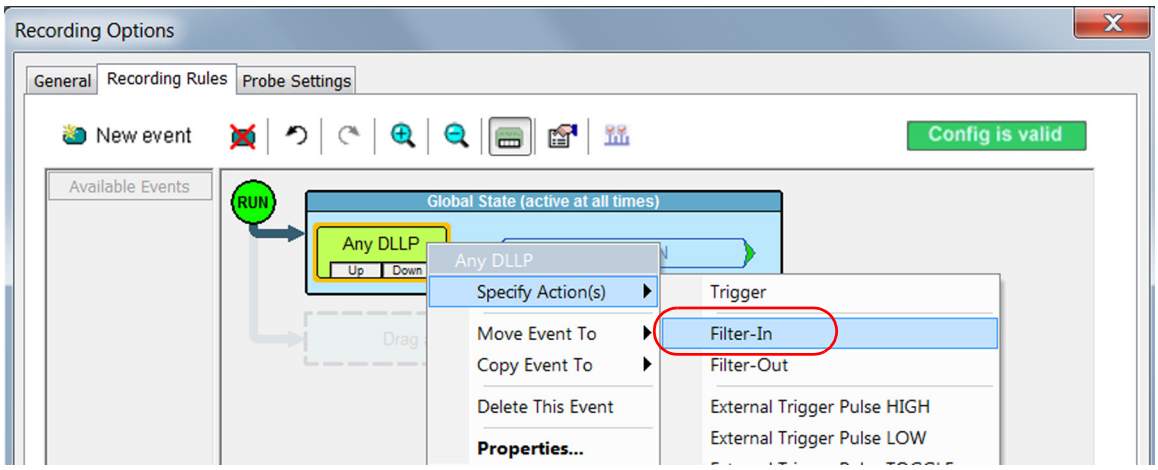


Figure 5.96: Filter In Option

Note: When a **Filter-In** is selected the analyzer filters out everything else by default except EDS.

5.14.8 Valid Configuration

In this case, you have chosen a Global State Filter-In on any DLLP and Sequence 1, State 1 to have an NVMe Command:ACQ Filter-In. This is a valid configuration as shown in Figure 5.97.

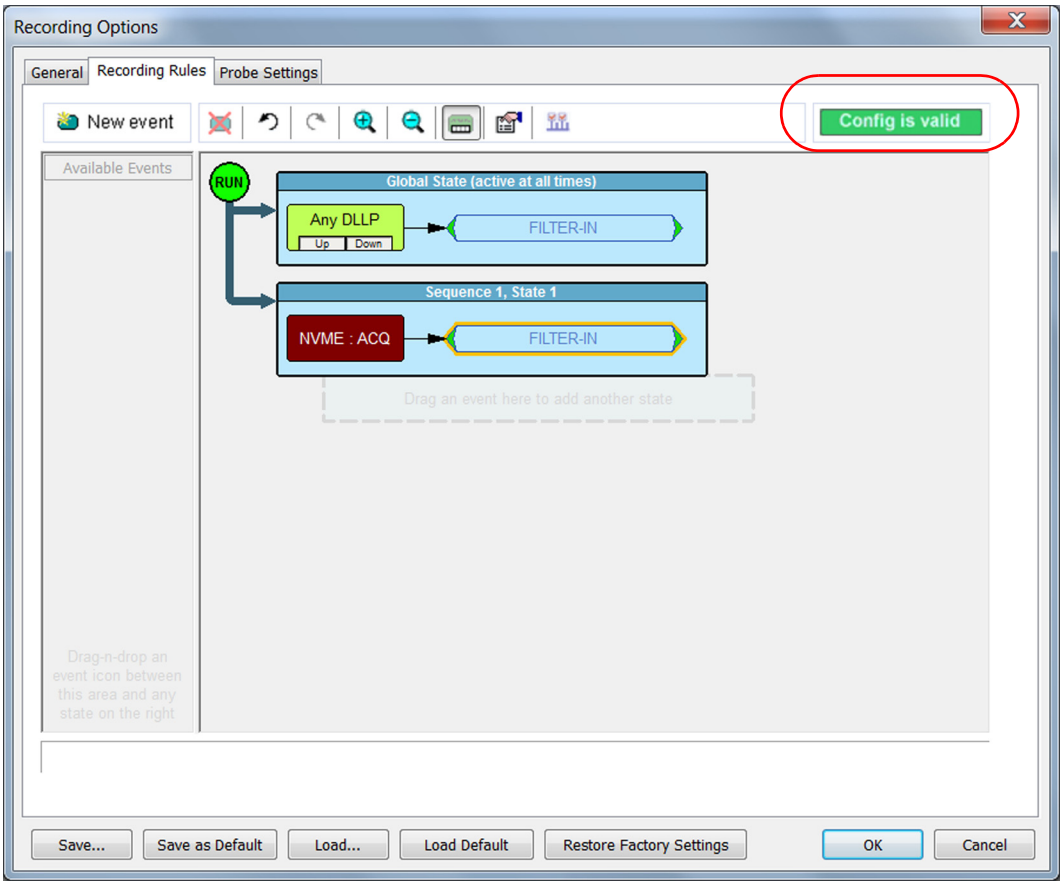


Figure 5.97: Filter In: Advanced Mode: Filter In Any DLLP and Any NVMe ACQ Command

Note: If you change the Global State to Any DLLP but switch to FILTER-OUT you'll get the following warning message: See Figure 5.98 on page 327.

5.14.9 Invalid Configuration

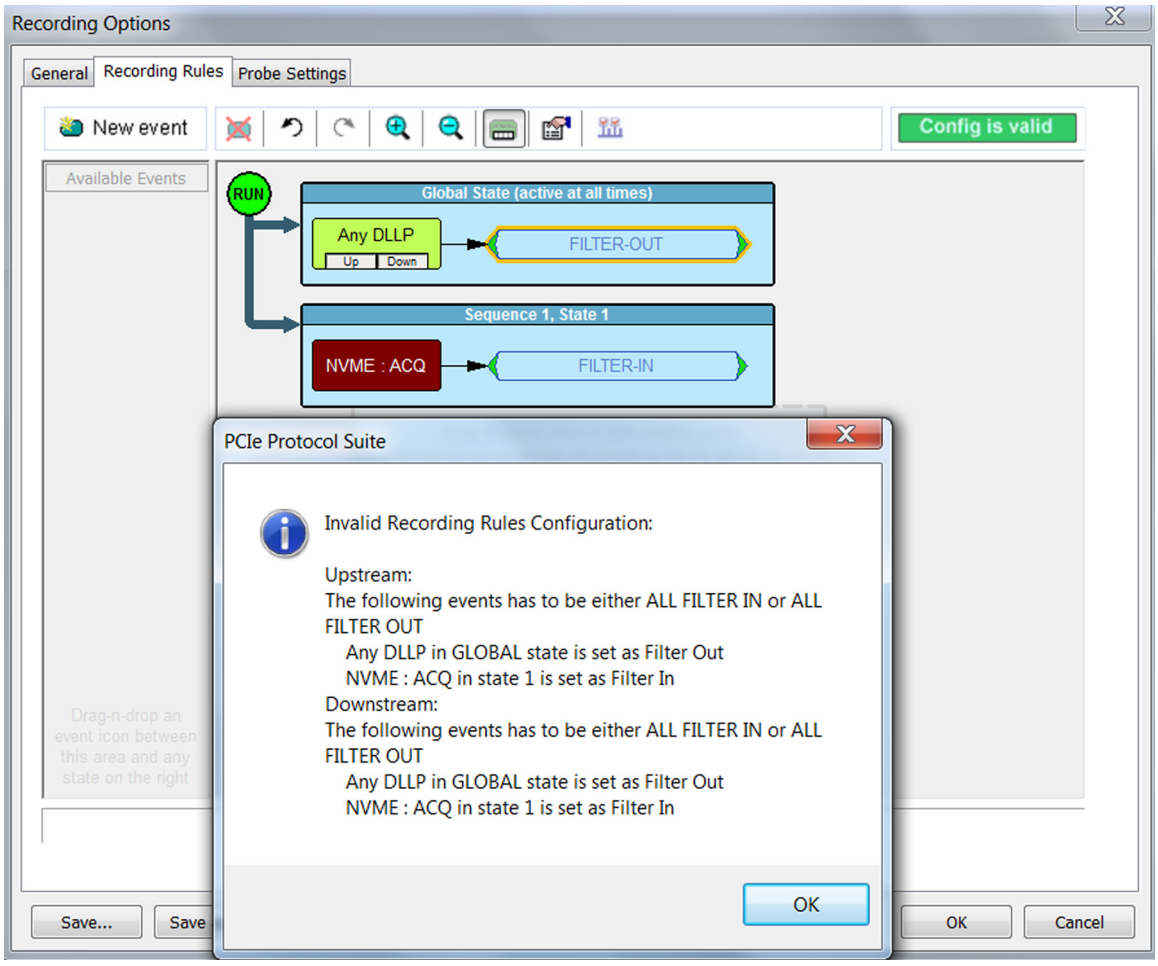


Figure 5.98: Warning Message for Invalid Configuration

The analyzer is warning you that you've set a Global Rule to Filter-Out Any DLLP and that condition will filter out the NVMe:ACQ Command you're looking for. So the recording rules have to be consistent. You'd get the same message if you set Any DLLP to Filter-In but set the NVMe:ACQ Command to Filter-Out. The warning message would pop up and if you hit OK, the **Config is Invalid** message will light up. See Figure 5.99 on page 328.

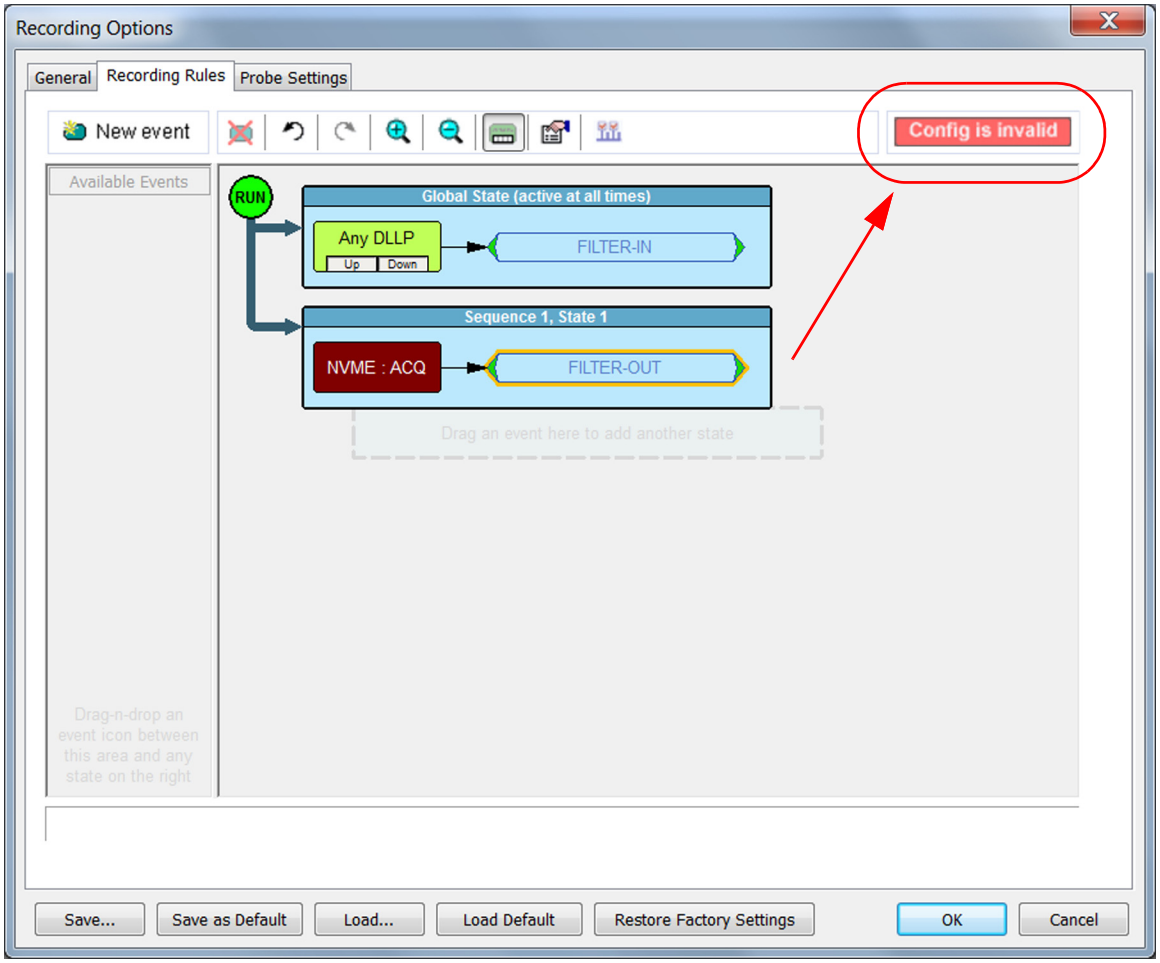


Figure 5.99: Filter In: Any DLLP, Filter Out Any NVMe:ACQ Command -> Invalid Config

So the tool won't let you try to set recording options that are logically inconsistent.

5.14.10 Filtering Events: (Electrical Idle, CLKREQ#, WAKE#)

To be able to Filter-In or Filter-out the following events (Electrical Idle, CLKREQ# and WAKE#), three conditions must be met:

- The event must be in a global state
- The event must be both asserted and de-asserted
- Triggering must be deselected

5.14.10.1 Example of CLKREQ# Filtering Enabled

See Figure 5.100 on page 329 and Figure 5.101 on page 330 for an example of CLKREQ# events in the global state, asserted and deasserted are both selected and triggering is deselected. Then you'll see that filtering of those events is enabled. After selecting the options you want click on the "OK" button.

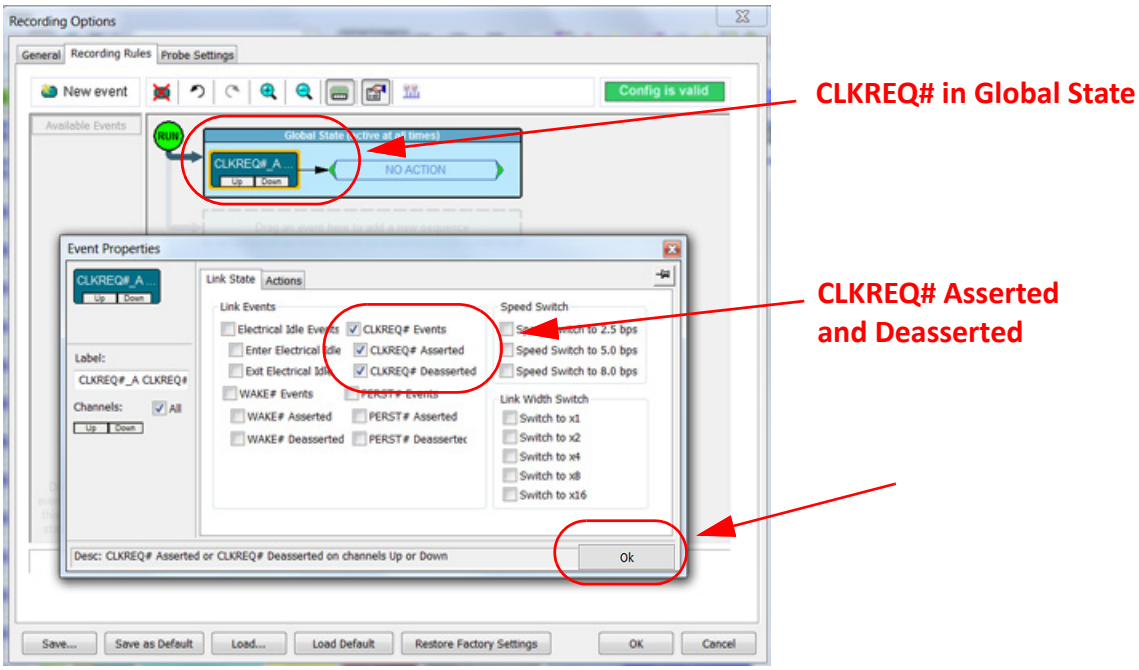


Figure 5.100: Link Event: CLKREQ# => Both Asserted and Deasserted Selected

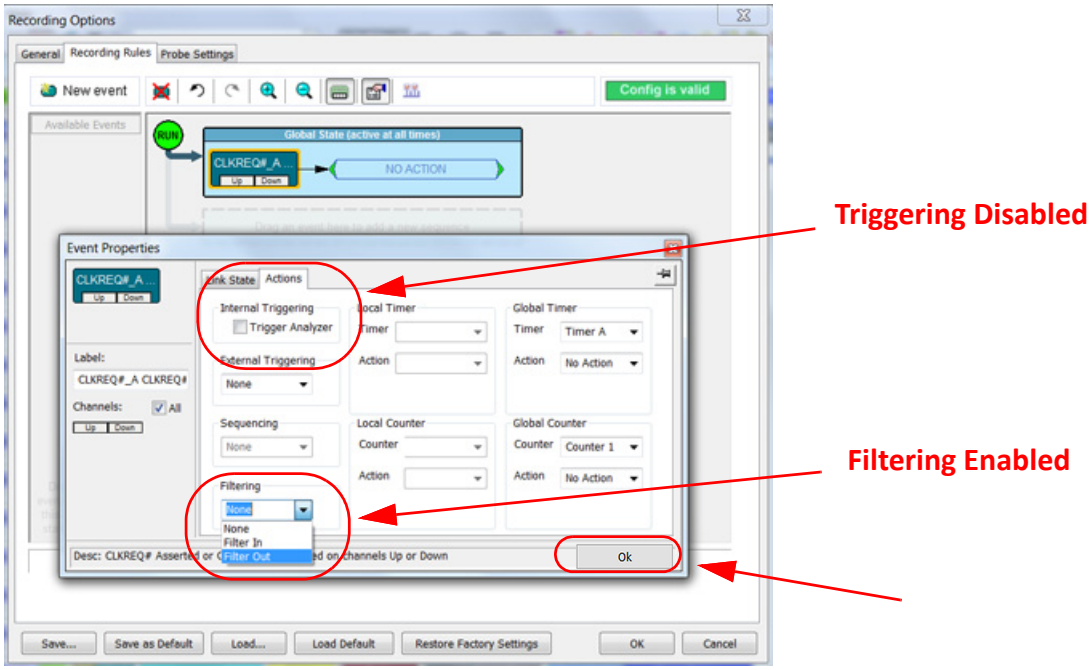


Figure 5.101: Link Event: CLKREQ# => Both Asserted and Deasserted => Filtering Enabled

5.14.10.2 Example of CLKREQ# Filtering Not Enabled

See Figure 5.102 for an example of CLKREQ# events in the global state, but only CLKREQ# has been asserted (deasserted is not selected) and triggering is deselected. So when one of the required conditions is not met (CLKREQ# being asserted and deasserted) Filtering is not enabled (see Figure 5.103 on page 331). After selecting the options you want click on the “OK” button.

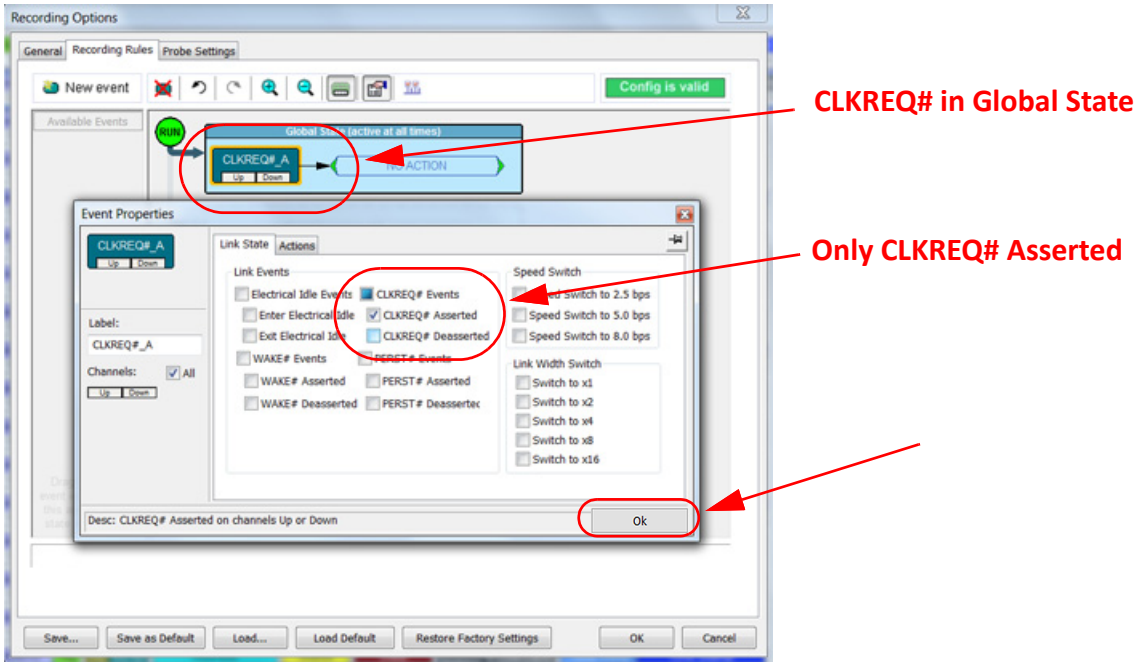


Figure 5.102: Link State: CLKREQ# => Asserted Only Selected

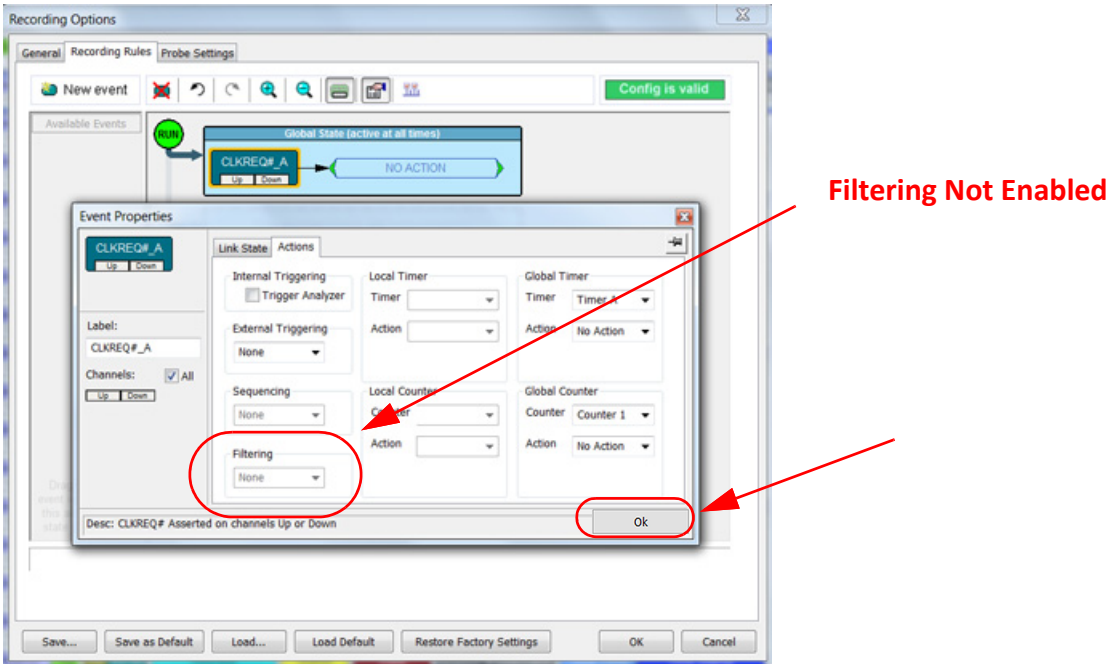


Figure 5.103: Link State: CLKREQ# => Asserted Only Selected => Filtering Disabled

5.14.11 Filtering Out NVMe CSTS, DLLP Ack and TLP Completions

To enable longer recordings, you can filter out NVMe CSTS, DLLP Acks and TLP Completions in Global Options by using the Advanced Recording Options. See Figure 5.104.

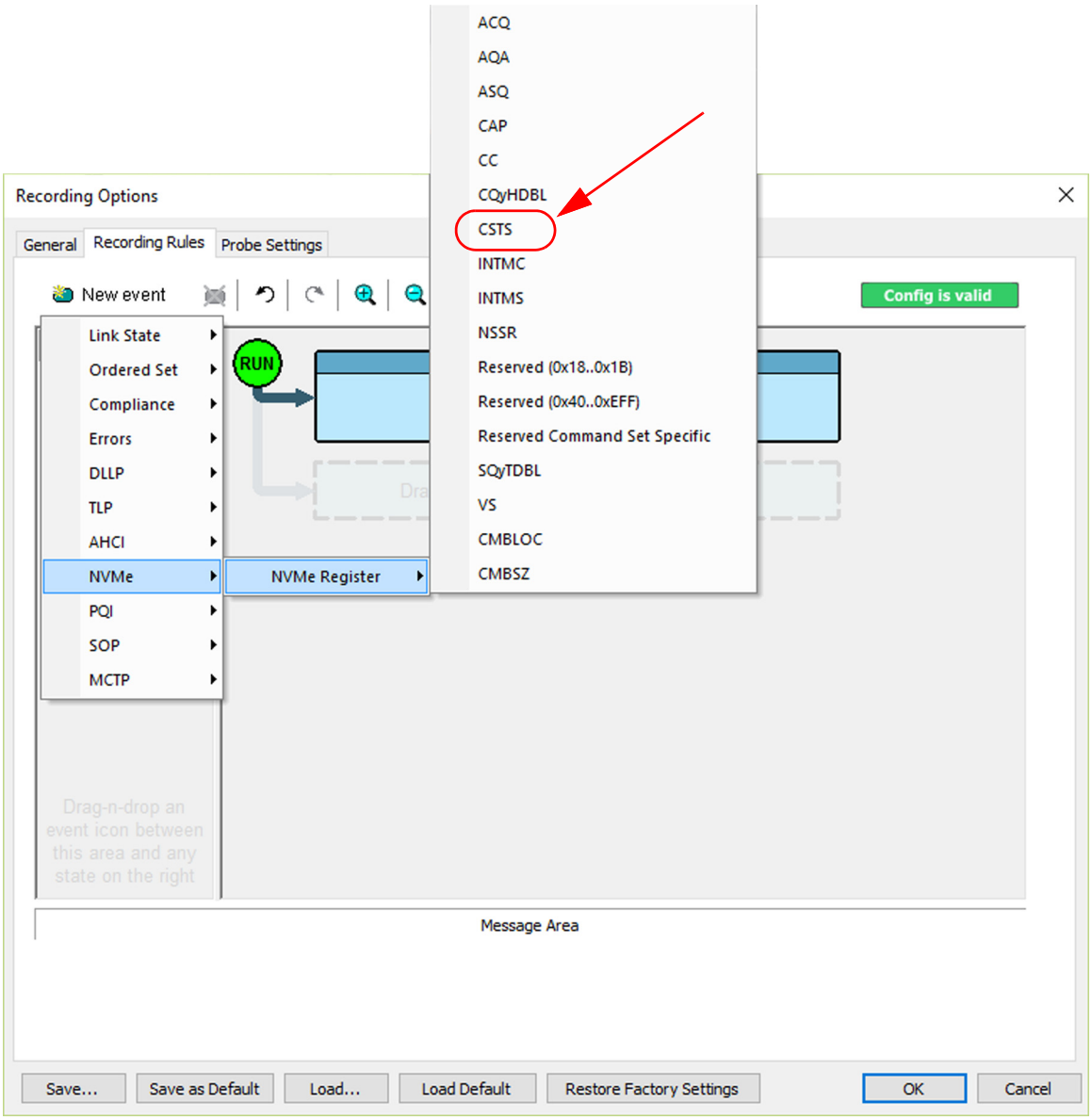


Figure 5.104: Filtering Out NVMe CSTS

If you select **New Event -> NVMe -> NVMe Register -> CSTS -> Actions** you'll have the option to filter out the CSTS events. See Figure 5.105 on page 333.

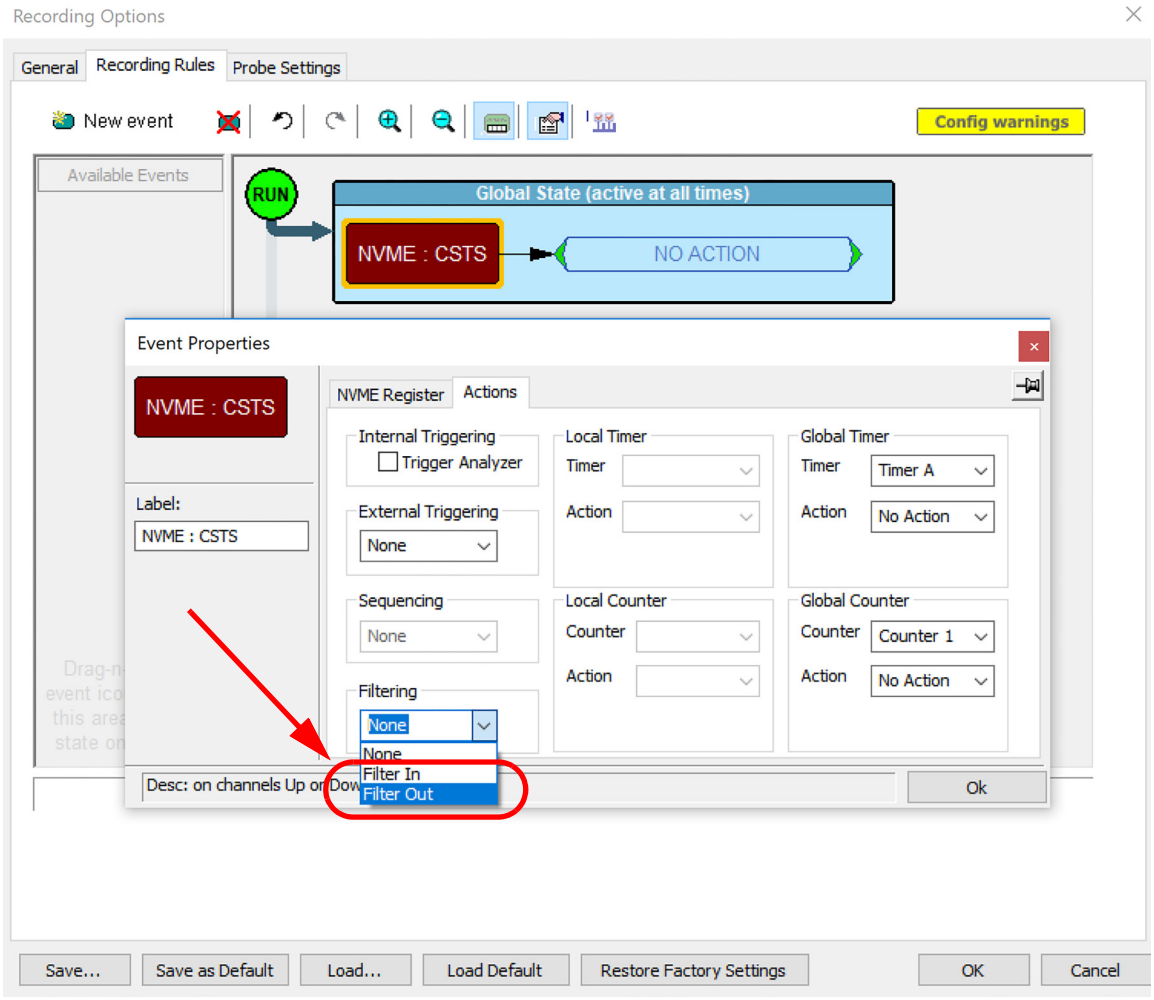


Figure 5.105: Selecting Recording Options: NVMe -> CSTS Event

Set the Action to Filter Out. Then click on “OK”. See Figure 5.106 on page 334.

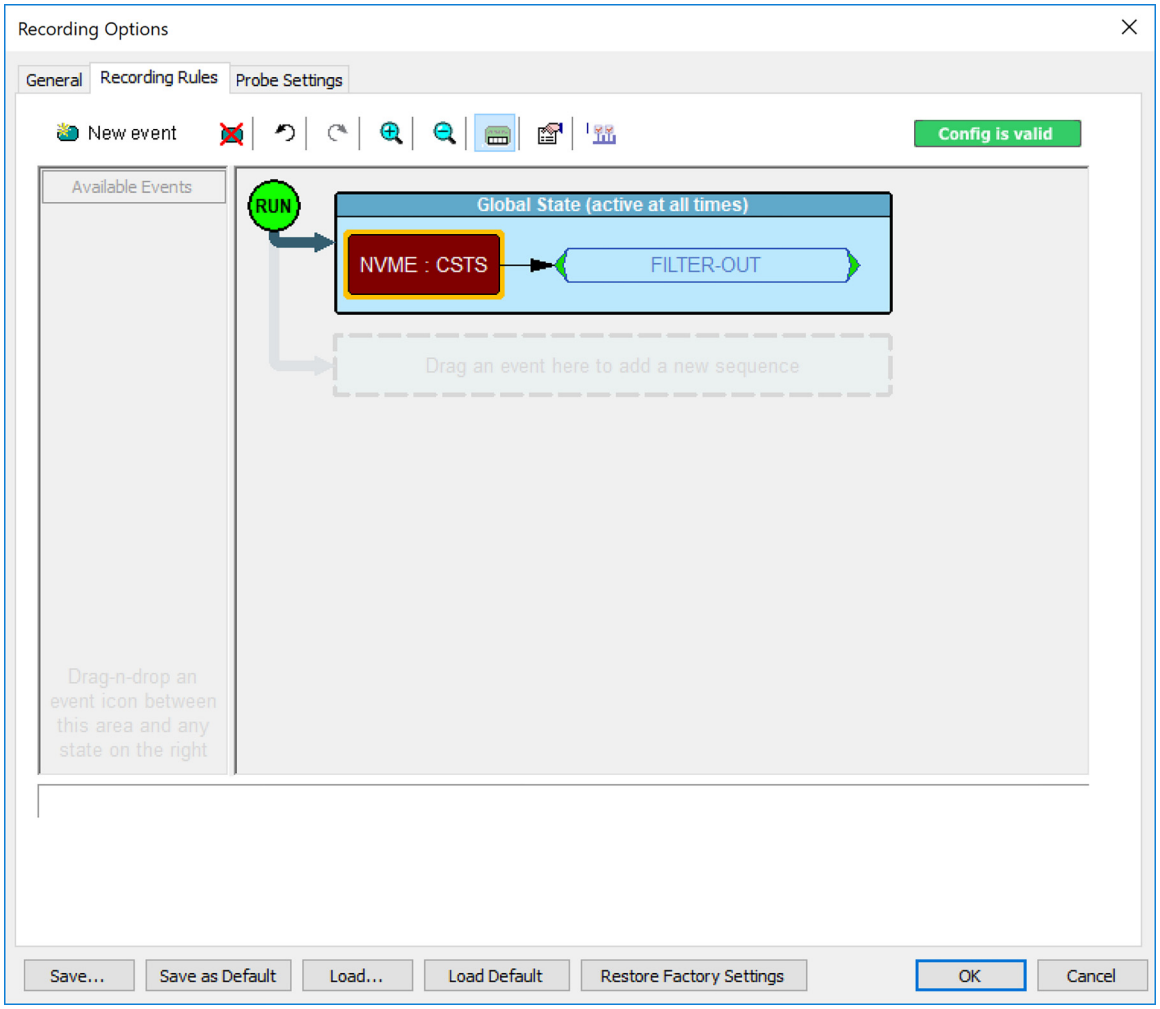


Figure 5.106: Recording Options: Filter Out NVME CSTS

Next add DLLP Acks to also be Filtered Out. See Figure 5.107 on page 335.

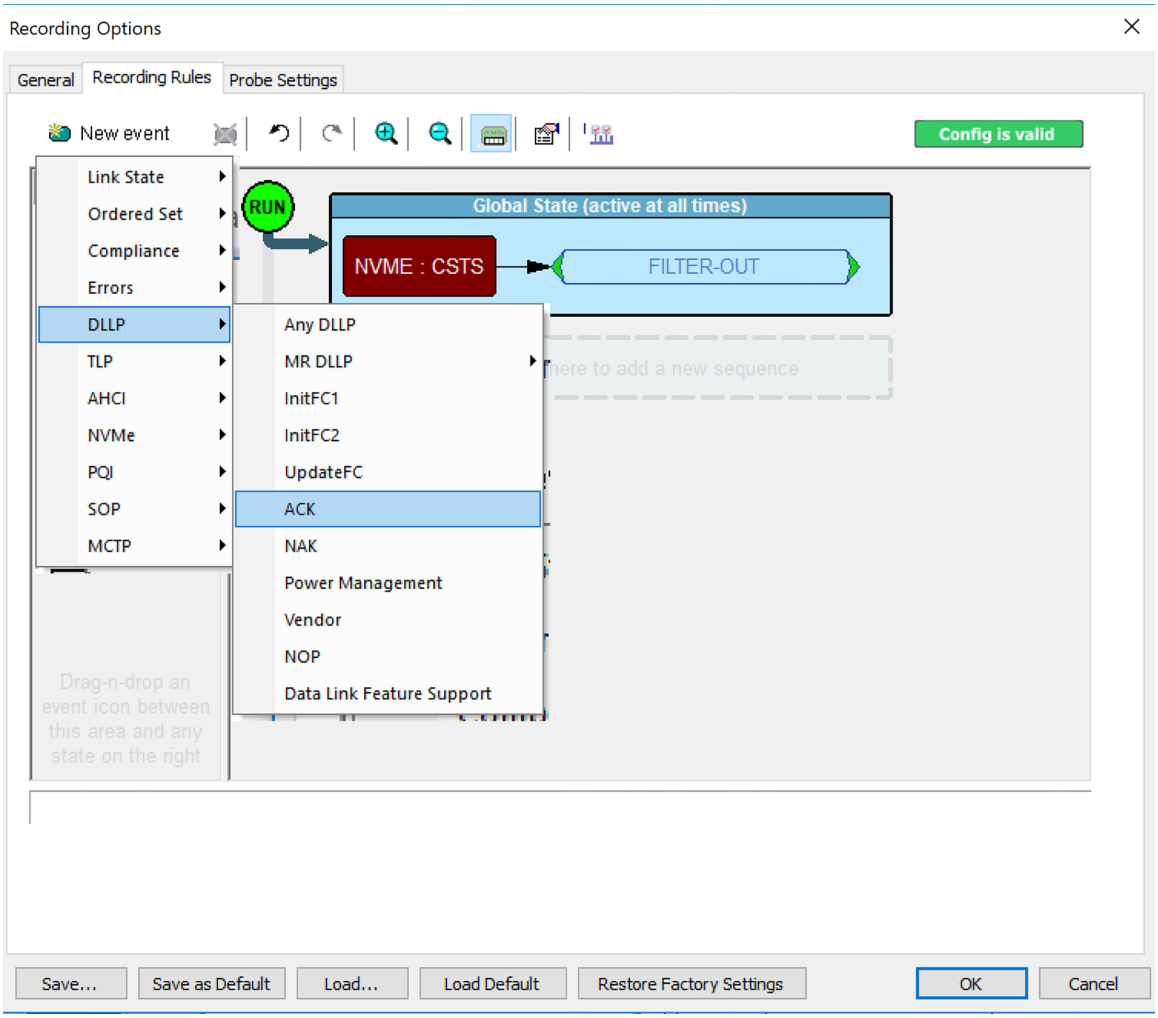


Figure 5.107: Recording Options: DLLP -> ACK

Click on “OK”, then add the Action -> Filter Out and place the DLLP in the Global State. See Figure 5.108 on page 336.

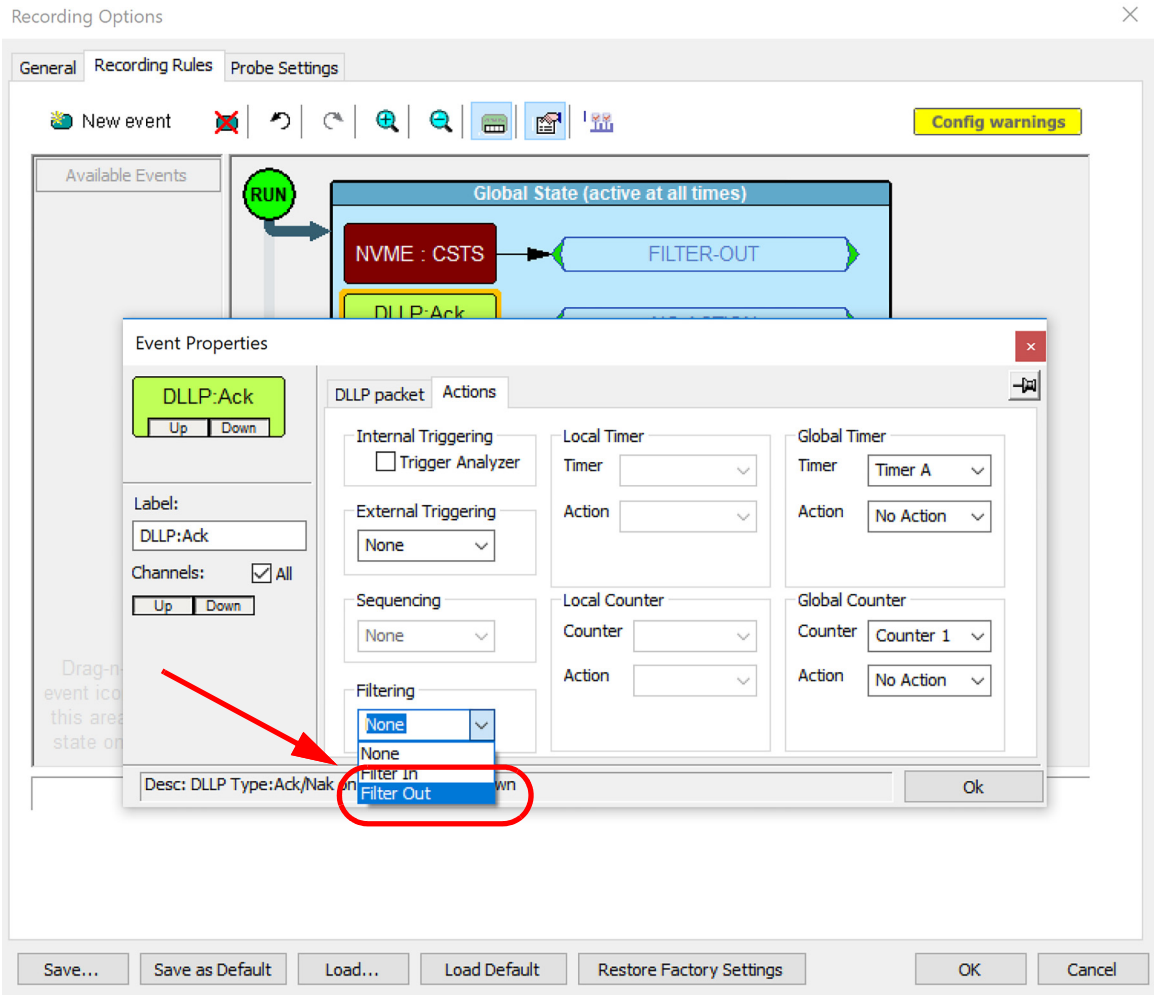


Figure 5.108: Select Action: Filter Out

Select Actions -> Filtered Out.

Click on “OK” and the DLLP:Ack with Action “Filter-Out” will be placed in the Global Options state. See Figure 5.109 on page 337.

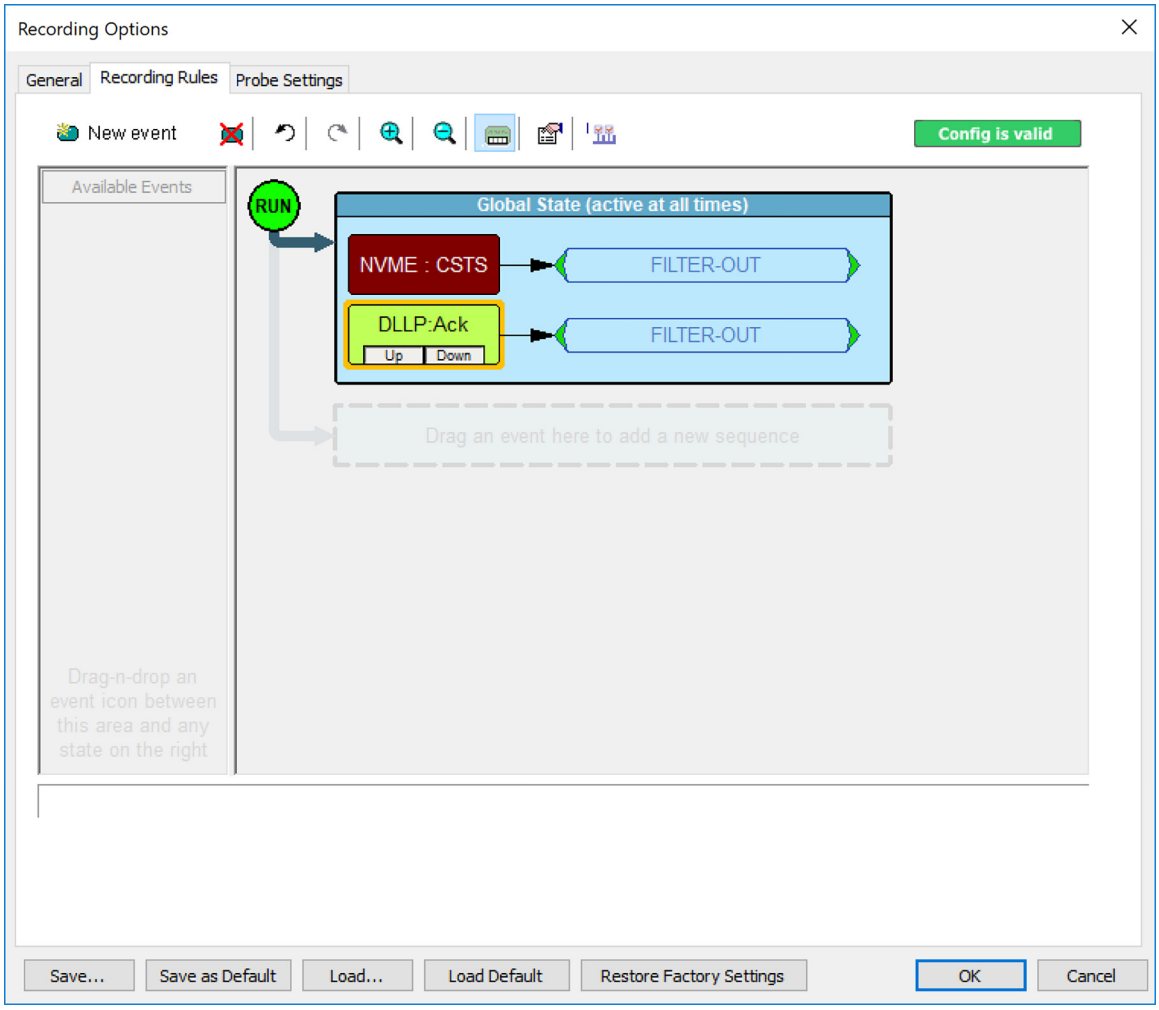


Figure 5.109: Place Recording Option: DLLP:Ack -> Filter-Out in the Global State

To these Recording Options you can add TLP Completions. See Figure 5.110 on page 338.

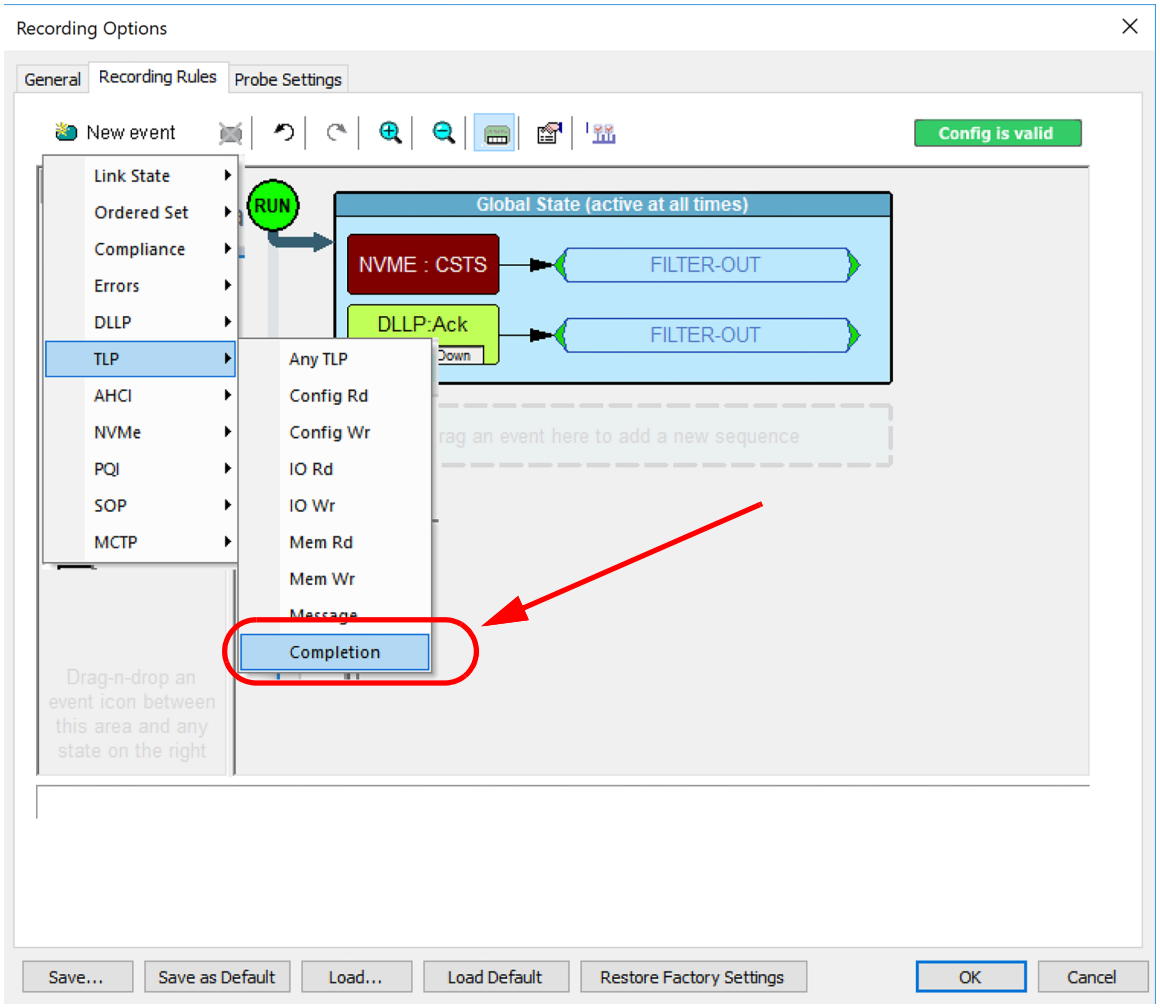


Figure 5.110: Recording Options: NVME, DLLP -> Filtered Out, Add TLP Completion

Then add the TLP Completion Layout Options. Set the Type to Cpl/CplD. See Figure 5.111 on page 339.

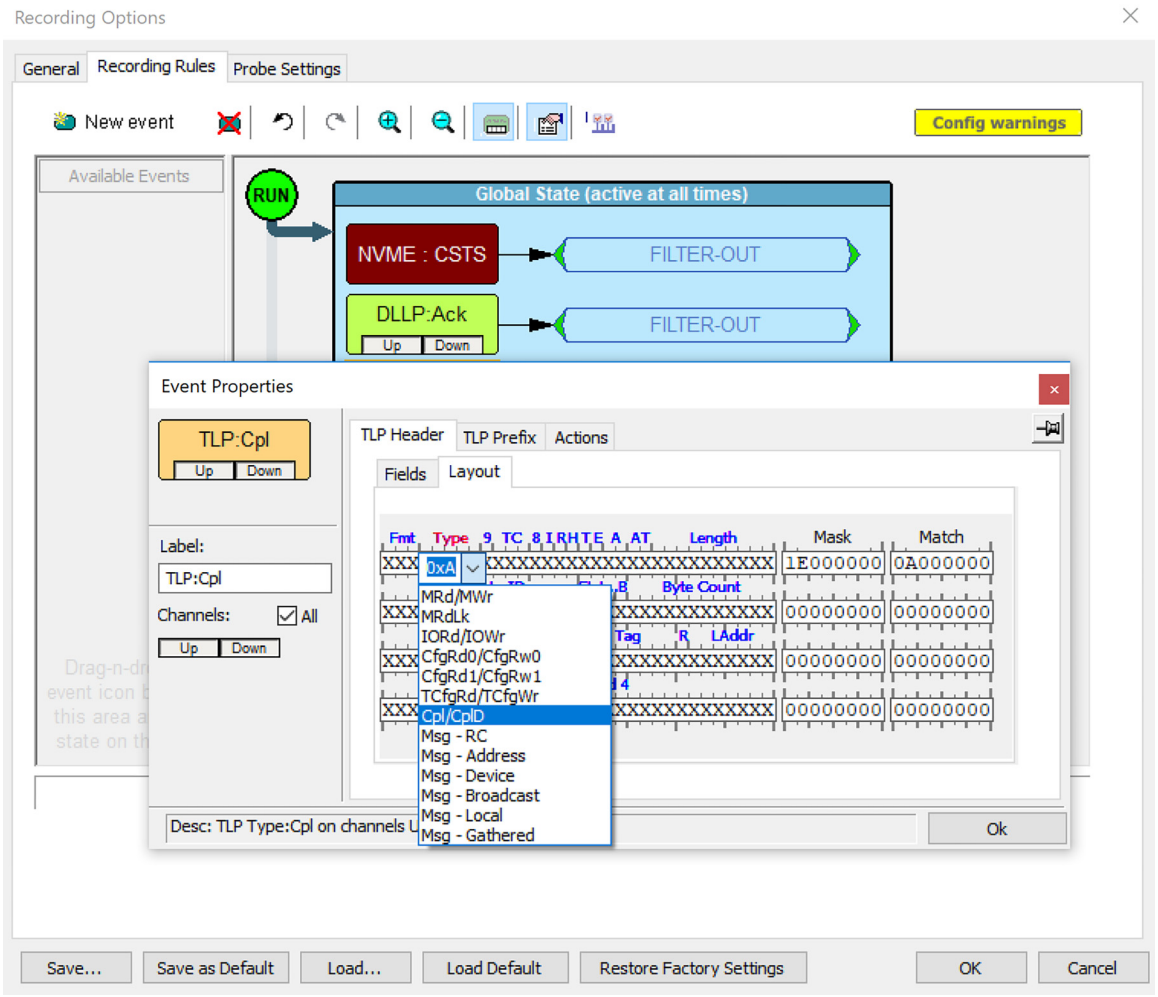


Figure 5.111: Recording Options: TLP:Cpl -> Select CPl/CplD

Next set the LAddr Layout Option to 0x1C. See Figure 5.112 on page 340

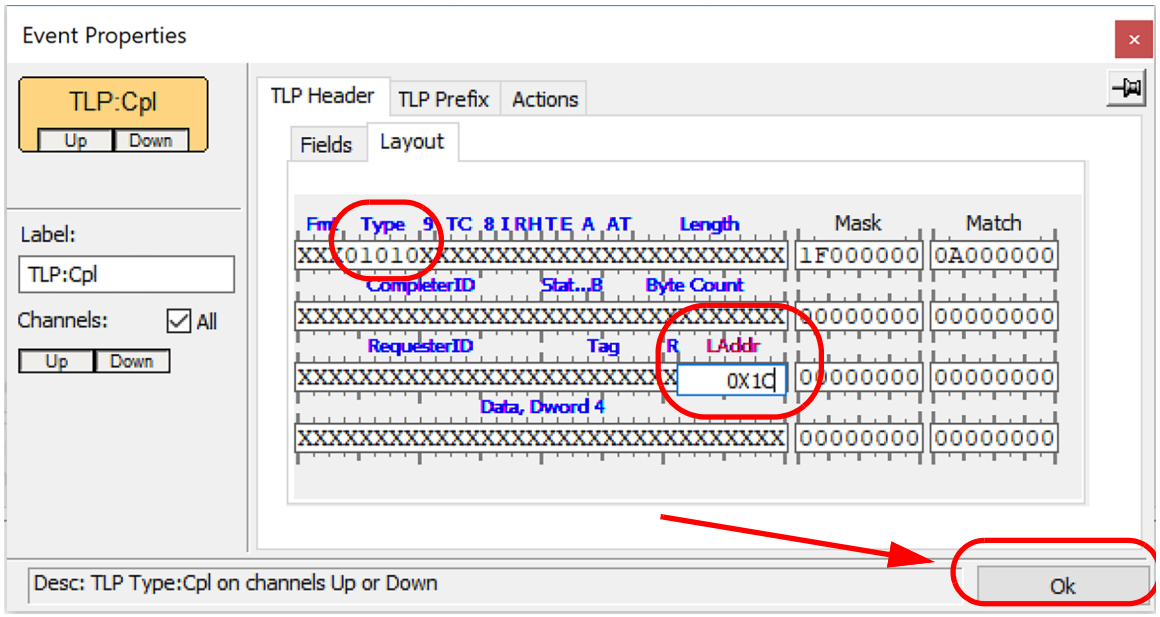
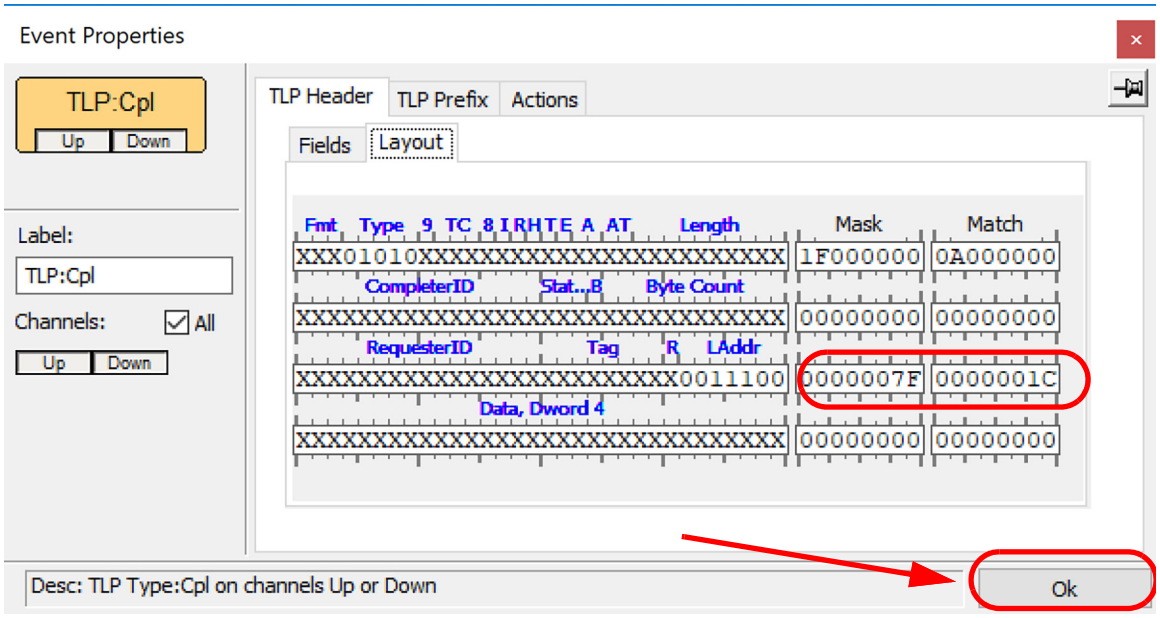


Figure 5.112: Recording Options: TLP:Cpl -> Layout Type: 01010, LAddr: 0x1C

This will set the Mask to 7F and the Match to 1C. See Figure 5.113.



Click on “OK” and then set the Action to Filter-Out. See Figure 5.113 on page 341.

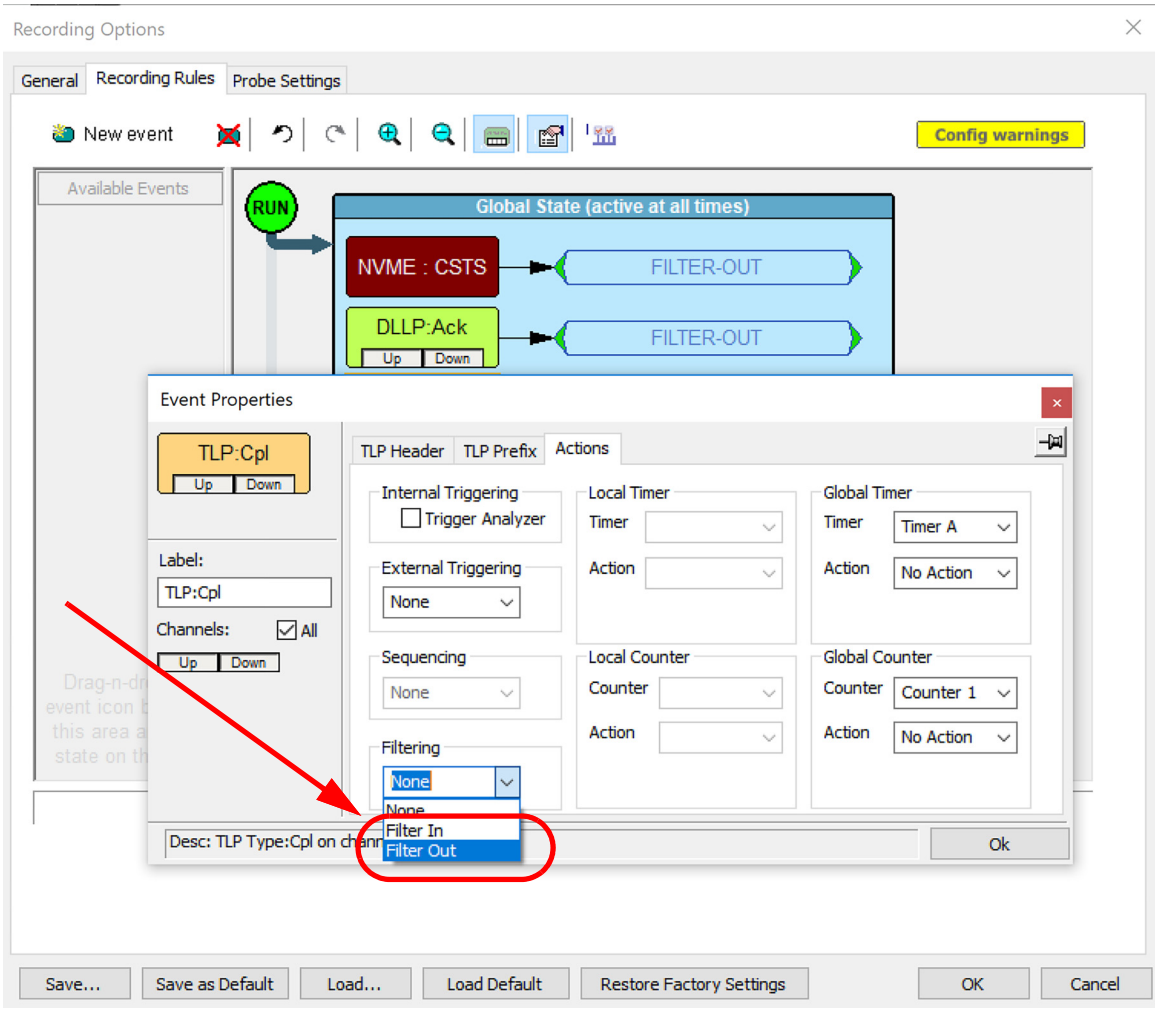


Figure 5.113: TLP:Cpl -> Actions: Filter-Out

Add this property to the Global State. See Figure 5.114 on page 342.

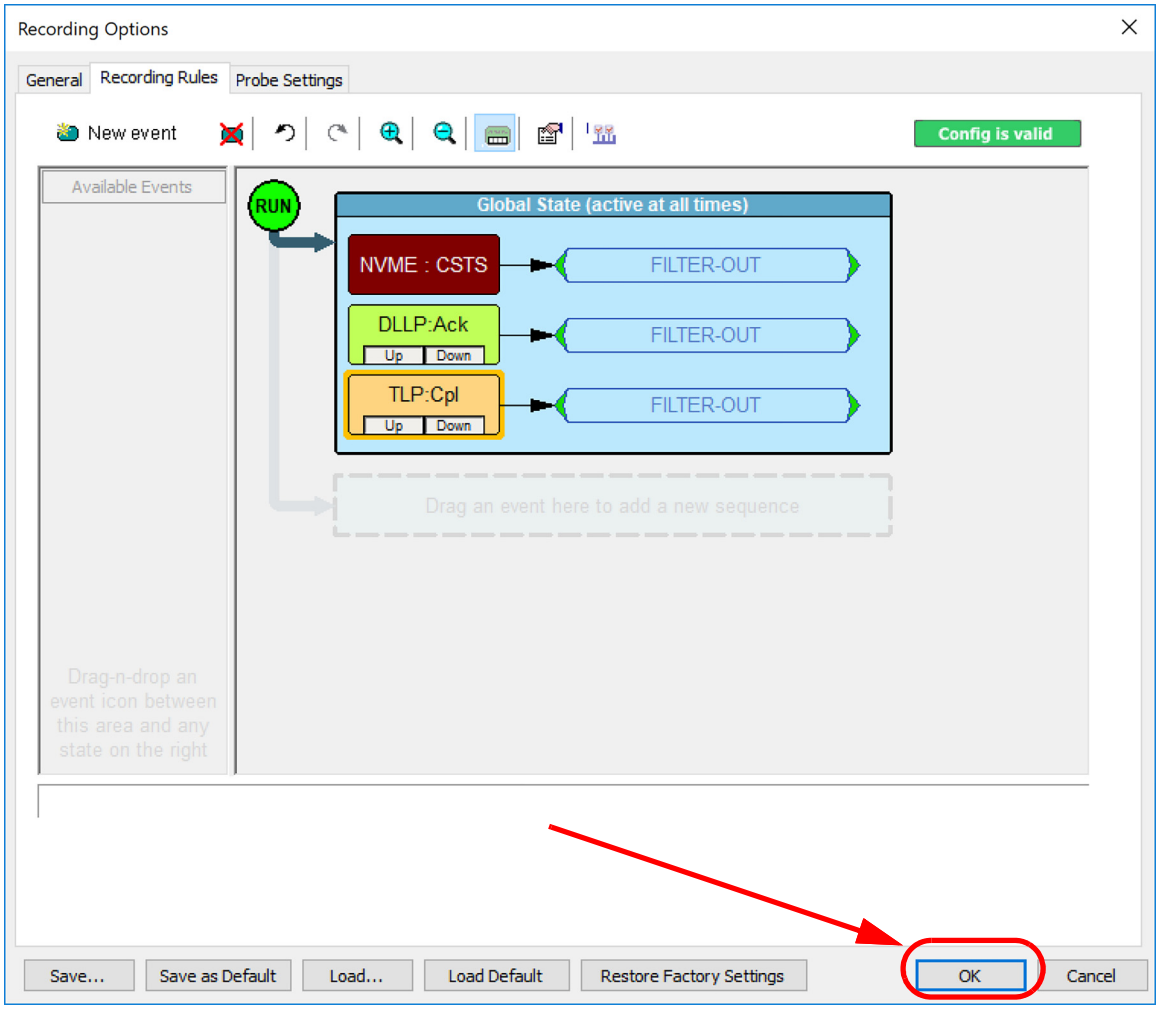


Figure 5.114: Recording Options: NVME, DLLP and TLP all Filtered-Out

Click on “OK” and these Properties will all be Filtered Out of the recording.

5.14.12 Triggering Configuration on a per Lane Basis

The Lane Trigger Configuration Icon (available on the Recording Options => Recording Rules toolbar see Figure 5.115) provides the user with the ability to add pre-conditions on specific lanes that the analyzer will use as an additional restriction on a defined triggering event.

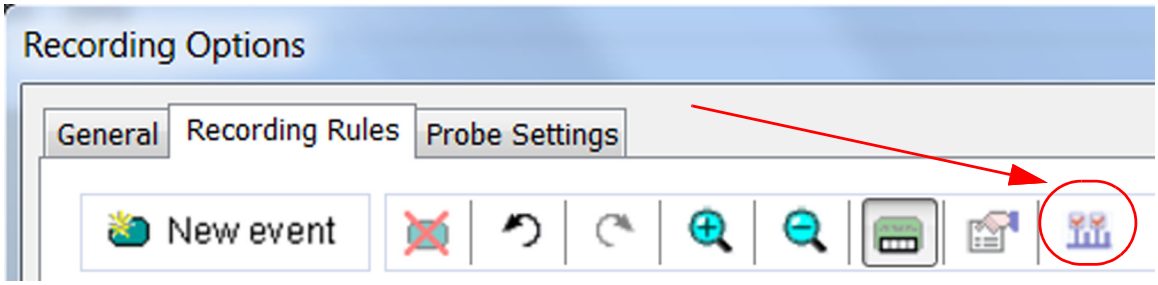


Figure 5.115: Lane Trigger Configuration

This option has three categories of events which can be made lane-based:

- DLLP/TLP Packets
- Errors
- Ordered Sets

Each of these events has restrictions on the lanes available, as spelled out in the GUI.

- These selections will be applied globally
- Lane selections will be applied to logical lane(s) and NOT physical lane(s)
- Default is “all Lanes”, but you can select one or more lanes as targets
- Filter-in/out will not function is you are using per lane triggering

5.14.12.1 DLLP/TLP Packets Category

For DLLP/TLP packets starting in selected lanes, the packet must start in lanes 0, 4, 8 or 12. One or more of these four lanes can be selected to look for the start of DLLP/TLP packets and the selection can be made for each direction by checking boxes.

See Figure 5.116.

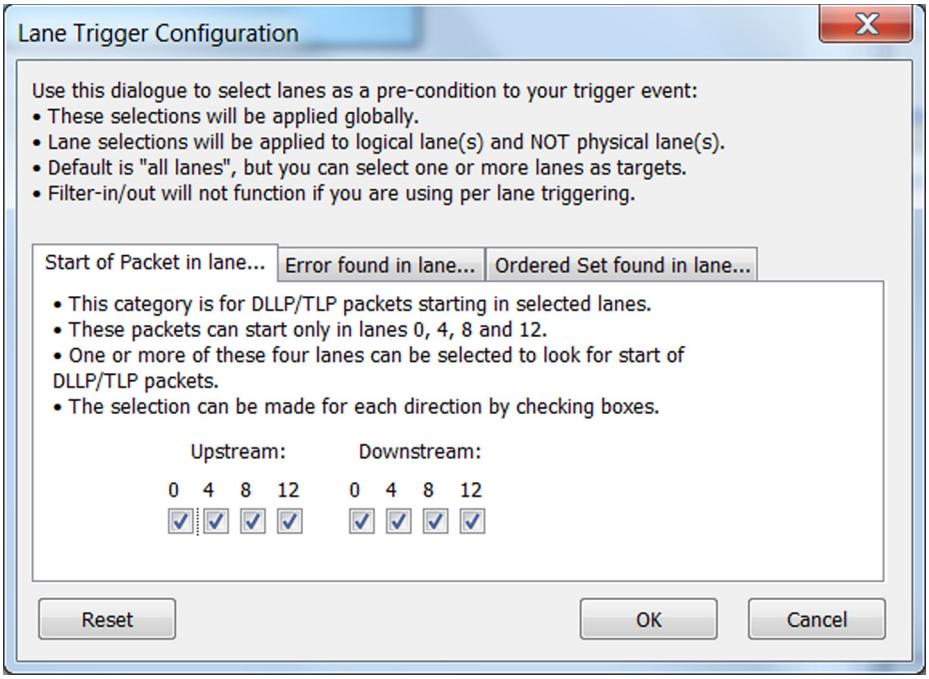


Figure 5.116: Start of Packet in lane GUI

5.14.12.2 Errors Category

Errors category can be used as a pre-condition to trigger on an event in selected Upstream or Downstream lanes. The types of errors that will be detected are limited to:

- Symbol errors
- Disparity errors
- Block errors

See Figure 5.117.

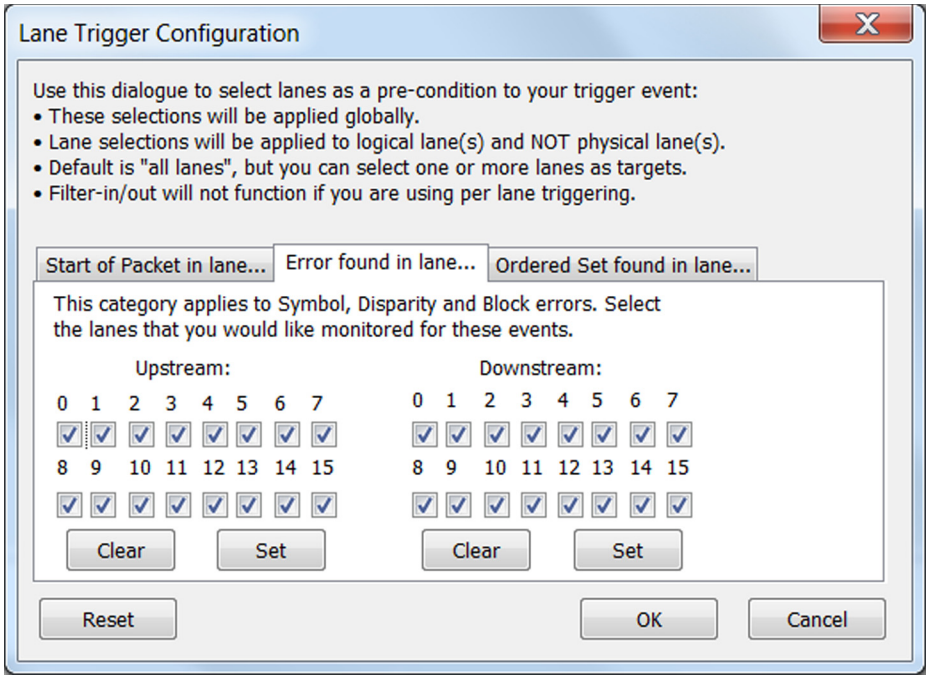


Figure 5.117: Error Found In Selected Lanes

5.14.12.3 Ordered Sets Category

This category includes all types of ordered sets (TS1, TS2, EIEOS, EIOS, Skip, FTS, and SDS).

If a specific lane is selected in the Event Properties dialog of a TS ordered set the same specific lane must be selected here or no triggering event will occur.

See Figure 5.118.

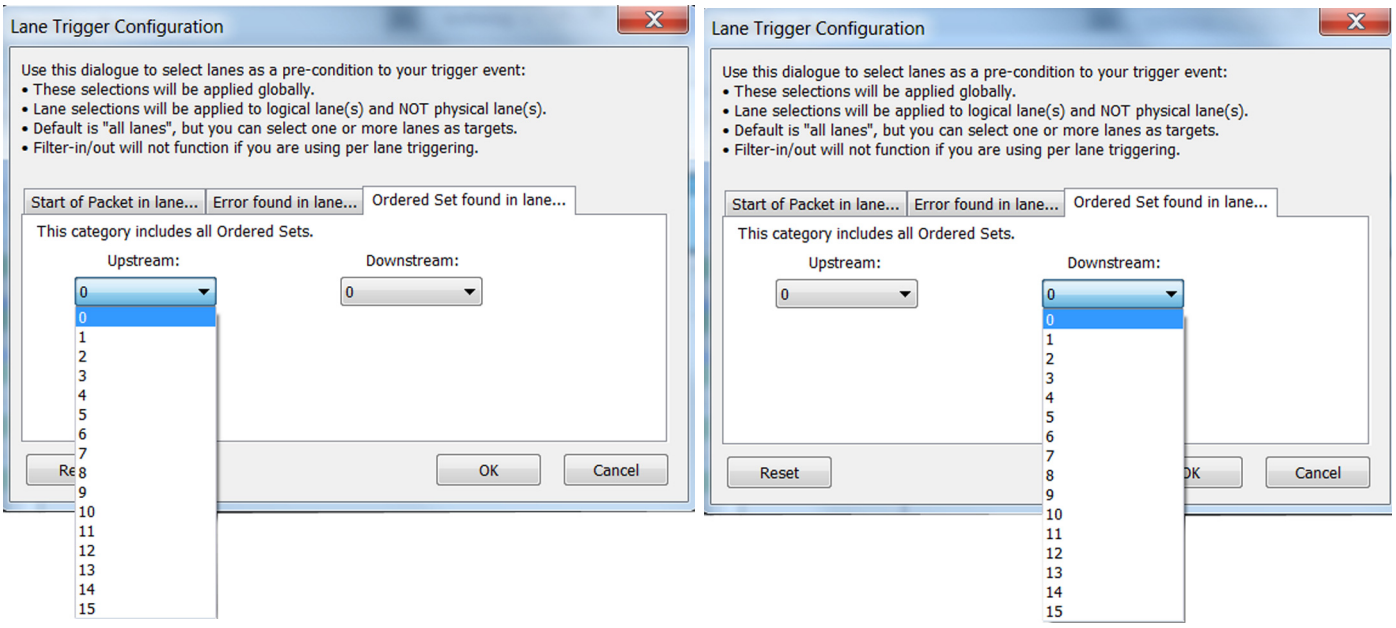


Figure 5.118: Ordered Sets Found in Upstream and Downstream Lanes

5.14.13 Lane Trigger Configuration

5.14.13.1 Example 1:

If you need to trigger on TLPs that start on lane 4 in the upstream direction perform the following selection (see Figure 5.119):

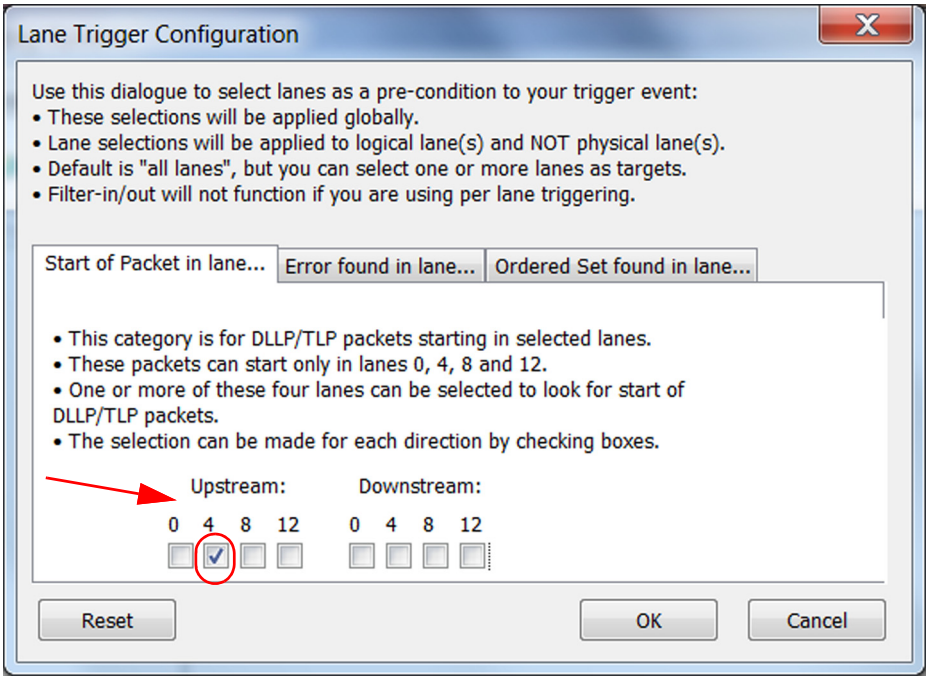


Figure 5.119: Lane Trigger Configuration: Example 1

Then select the appropriate event to trigger the analyzer.

5.14.13.2 Lane Trigger Configuration Example 2:

If you need to trigger the analyzer on errors happening on lanes 4 and 6 in the upstream direction, perform the following selections:

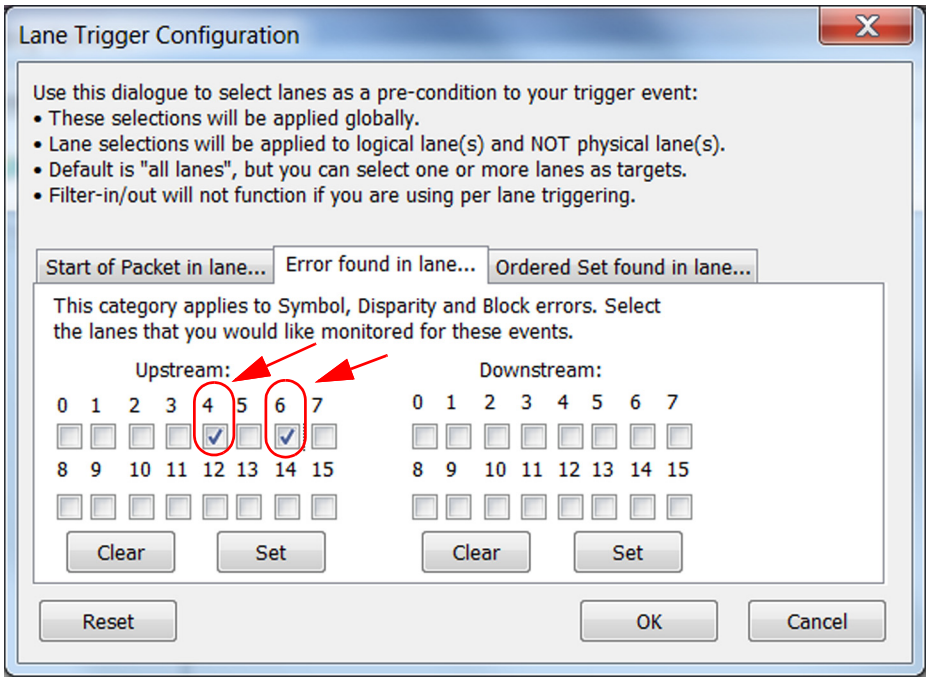


Figure 5.120: Lane Trigger Configuration: Upstream Errors on Lanes 4 and 6

Then select the appropriate event to trigger the analyzer.

5.14.13.3 Lane Trigger Configuration Example 3:

If you need to trigger on a TS1 Event with Link Number = 00 and Lane Number = PAD that happens on Lane 3 only in the Downstream direction, perform the following selections for Lane Triggering (see Figure 5.121):

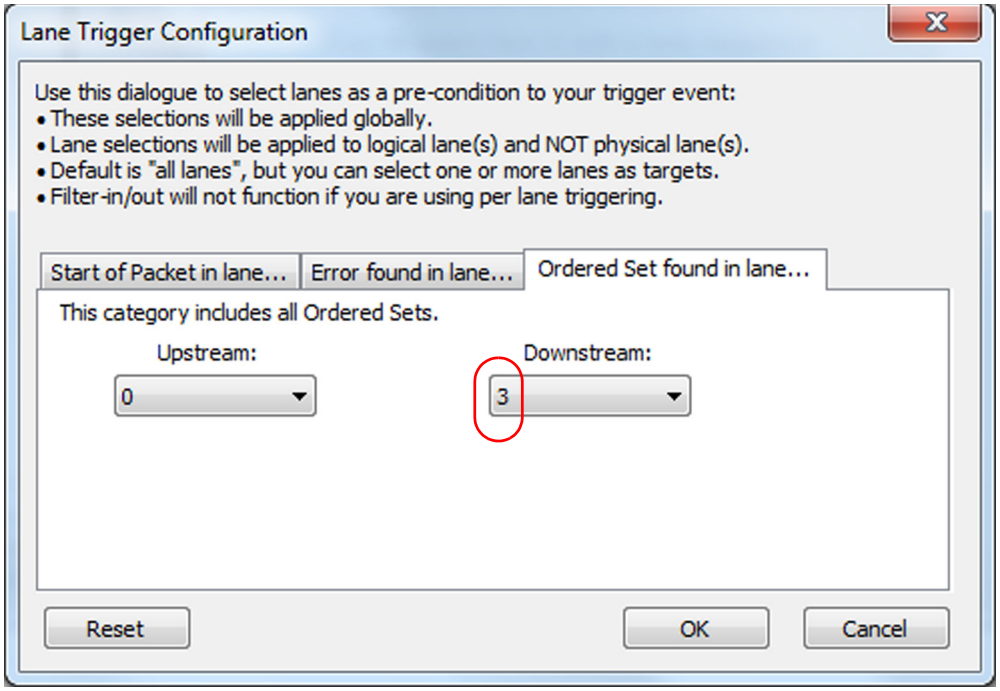


Figure 5.121: Lane Trigger Configuration: Downstream TS1, Downstream, Lane 3

Then select a TS1 Event and select only the Downstream direction, set Link Number = 00 and Lane number = PAD fields (see Figure 5.122). After selecting the options you want click on the “OK” button.

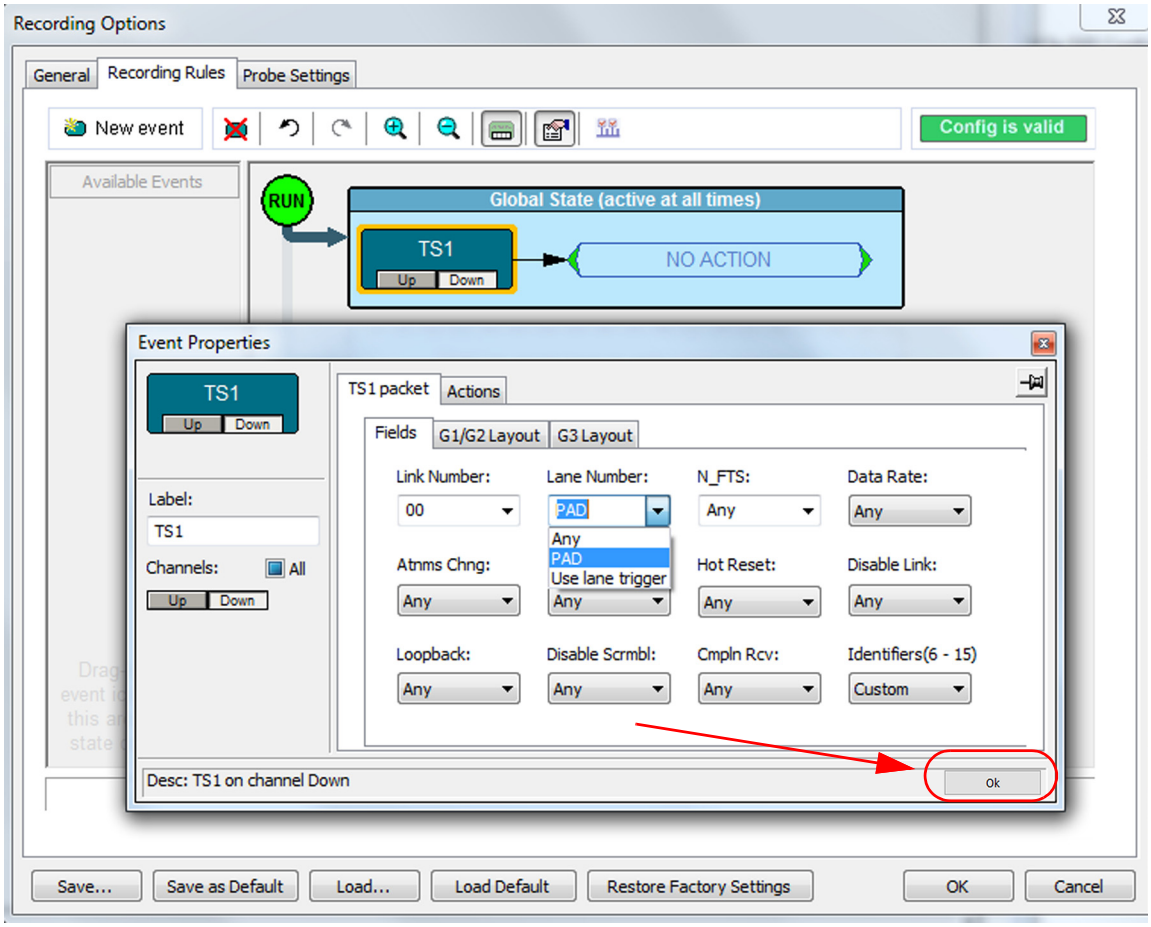


Figure 5.122: Setting the Event Properties for TS1 Downstream

Finally, set the Action Tab to trigger the analyzer (see Figure 5.123 on page 350). After selecting the options you want click on the “OK” button.

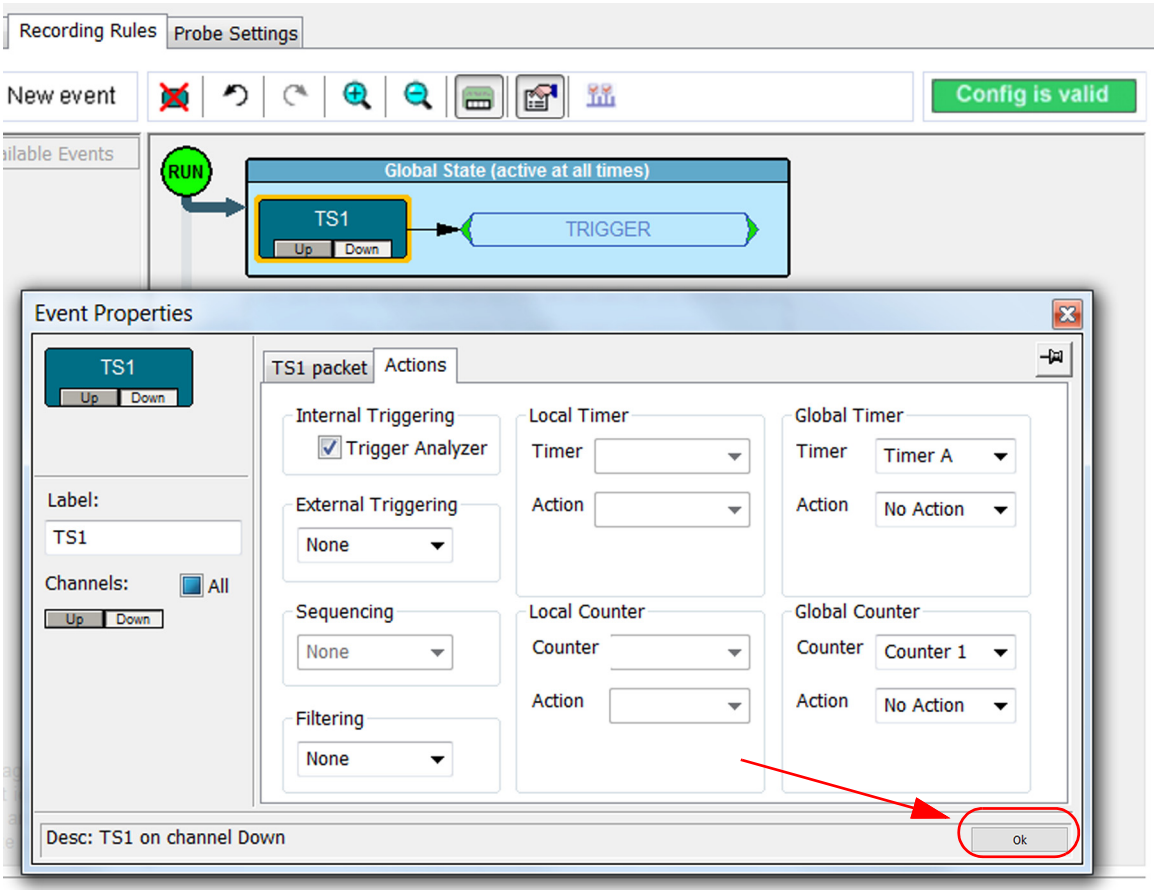


Figure 5.123: Event Properties: Actions = Trigger Analyzer

Now the analyzer will be triggered on a TS1 Event with Link Number = 00 and Lane Number = PAD that happens on Lane 3 only in the Downstream direction.

5.14.14 Counter

Counters can be created for any specific event or for multiple events (see Figure 5.124 on page 351). Counters function similar to an event and are independent of the event, thus allowing greater flexibility. You can select a counter for any event and if both channels are selected you can set the counter to count upstream and downstream. Counters can be reset providing further flexibility. The counter once set lives in the State. In an Advance to Sequence state once the action proceeds from one sequence state to the next, the counter in the preceding state will stop and the counter in the current state will start.

There are two Counters for the Global State and four Counters for the Sequence State.

The counters have different colors for the Global State and Sequence State. Each color signifies a different meaning in the Global and Sequence states.

Note: Counters can be controlled only from one direction not both, meaning starting, reset and incrementing must be done from events occurring in the same channel (upstream or downstream) of the selected counter.

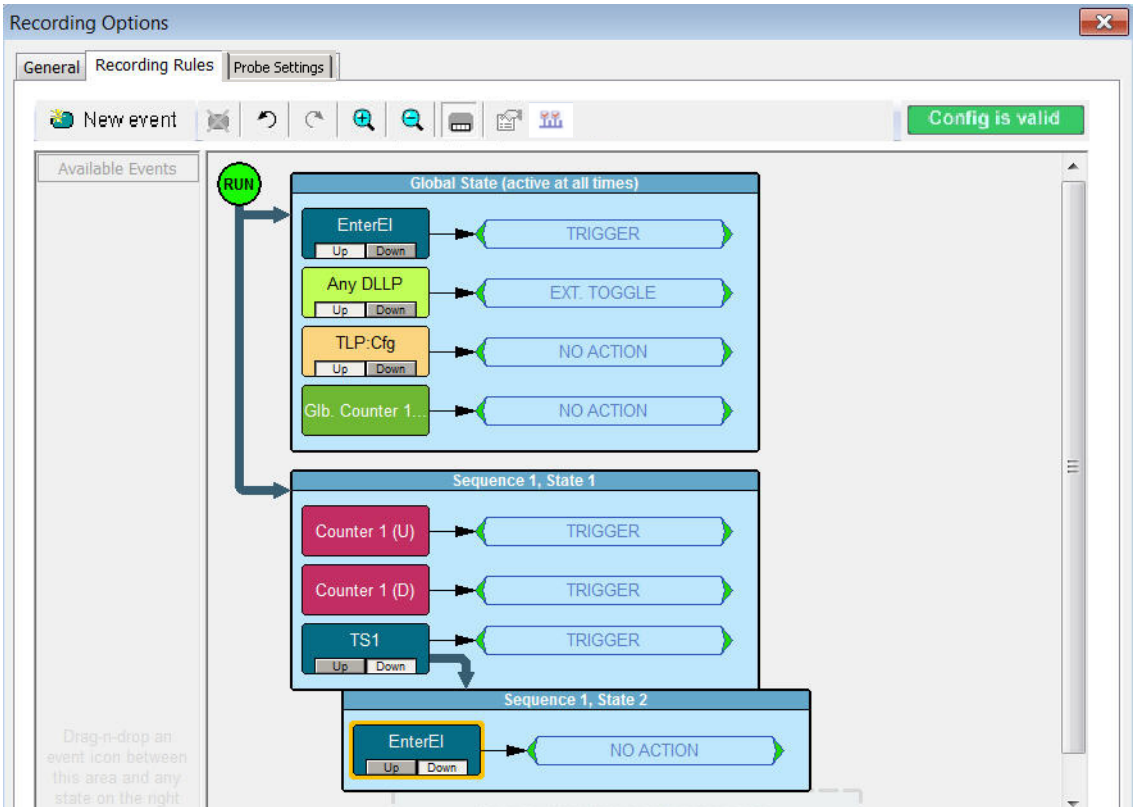


Figure 5.124: Global and Sequence State Counters

As shown in Figure 5.124 there is a Global Counter 1, set to the value of 2 on channel up displayed in green in the Global State and there are two counter 1s, set to the value of 2, one counting upstream and the other counting downstream displayed in pink in the Sequence State.

5.14.14.1 How to Set a Counter

Counters are events and you can add a counter to the Global State or the Sequence State as an event by doing the following:

Right-click in the blue space in the Global or Sequence State and **New Event > Counter > UpStream or DownStream**. See Figure 5.125 on page 352.

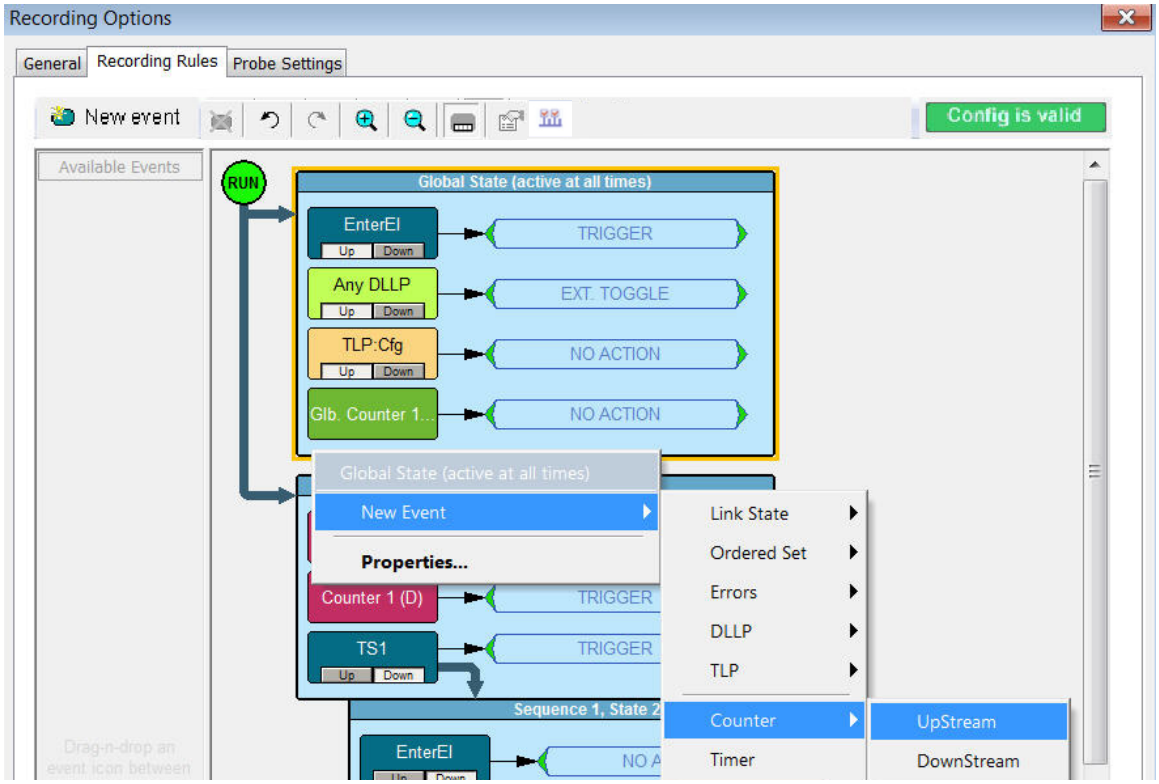


Figure 5.125: Setting Global and Sequence State Counter Events

5.14.14.2 How to Increment or Reset a Counter

You can Increment or Reset counters in the Global State and in the Sequence State by performing the following steps:

1. Open the Recording Rules page, select an event, and drag it to the **Global State** or **Sequence** cells. For details on these steps (see "Events with Channels" on page 359).
2. Right-click on an event and select **Specify Actions > Increment Global Counter > Global Counter 1** from the menu (see Figure 5.126 on page 353).

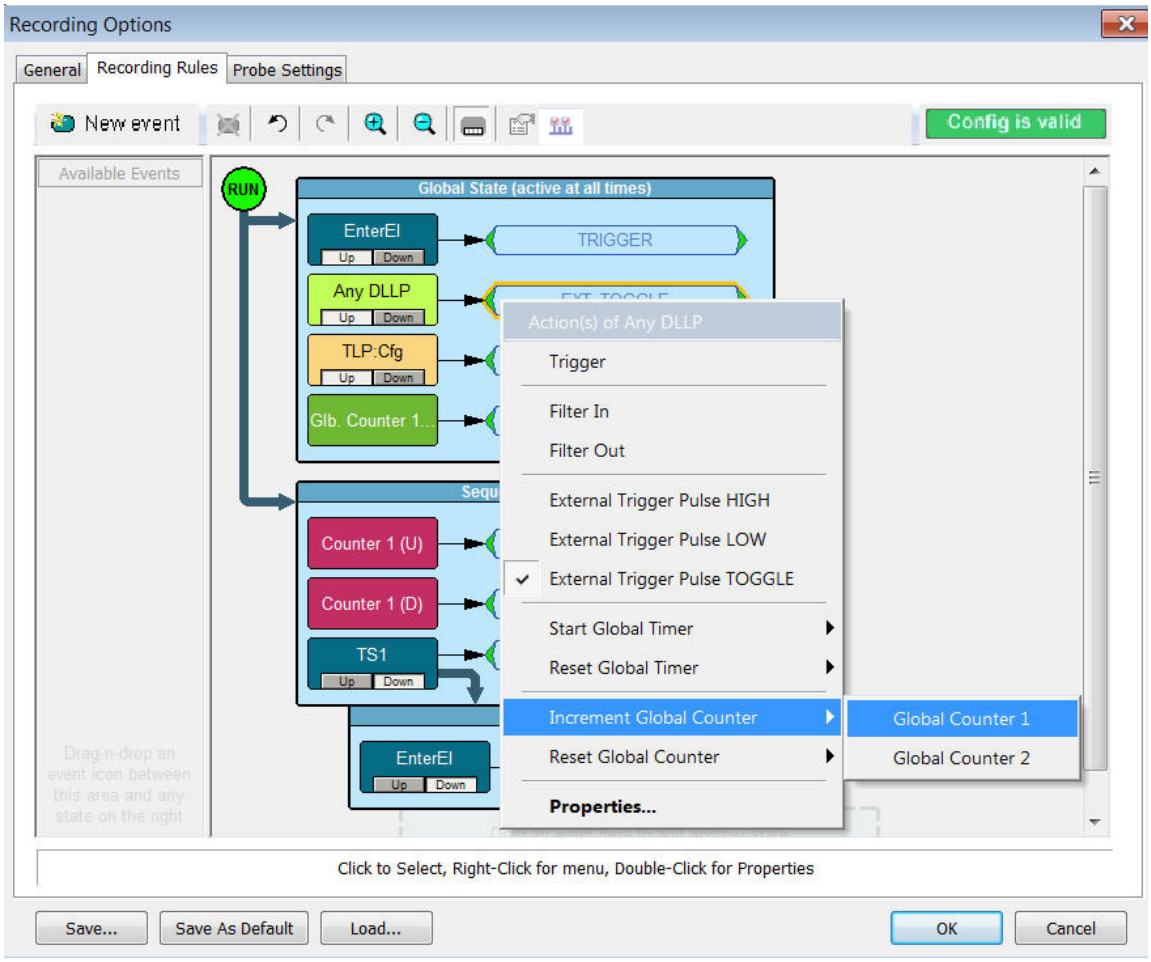


Figure 5.126: Incrementing and Resetting Global and Sequence State Counters

Note: Listed below are some of the considerations to note about the counter functionality.

1. If a counter is reset, it will restore to it's original value, in this case the value defined by the user.
2. Resetting a counter will stop it and set it to it's original value.

3. Local counters for a particular state will automatically reset if the sequencer advances to another state. Example: "Counter A" in State 1 and "Counter A" in State 2 are different timers not related to each other.
4. Local counters are controlled by events defined in the same state where the counters are defined.
5. In case of competing actions to control global counters using the same event from global and local states, the control from local states takes priority.

5.14.14.3 Changing the Value of the Counter

To change the value of the counter:

1. Double-click on the Counter.
2. Enter a new value in the pop-up dialog. This causes the new value to appear in the counter button.

5.14.14.4 Deleting a Counter

To delete a counter

1. Right-click on the Counter.
2. Select **Delete This Event.** The counter will disappear from the event.

5.14.15 Timer

The Timer has two options which are Start and Reset. When set to Start it starts the timer and when set to Reset it resets the timer to its initial value. When the timer count is down to 0 the action is triggered.

The Global State timer can trigger, start an action. It can also affect some other timers and counters.

The timers have different colors for the Global State and Sequence State. Each color signifies a different meaning in the Global and Sequence states.

There are two Timers for the Global State and four Timers for the Sequence State.

Note: Timers can be controlled (Start/Reset) deterministically from events happening in any channel (upstream or downstream direction) as long as these events are more than 380 ns apart. For timers controlled by events happening on a single direction the control happens at the line rate.

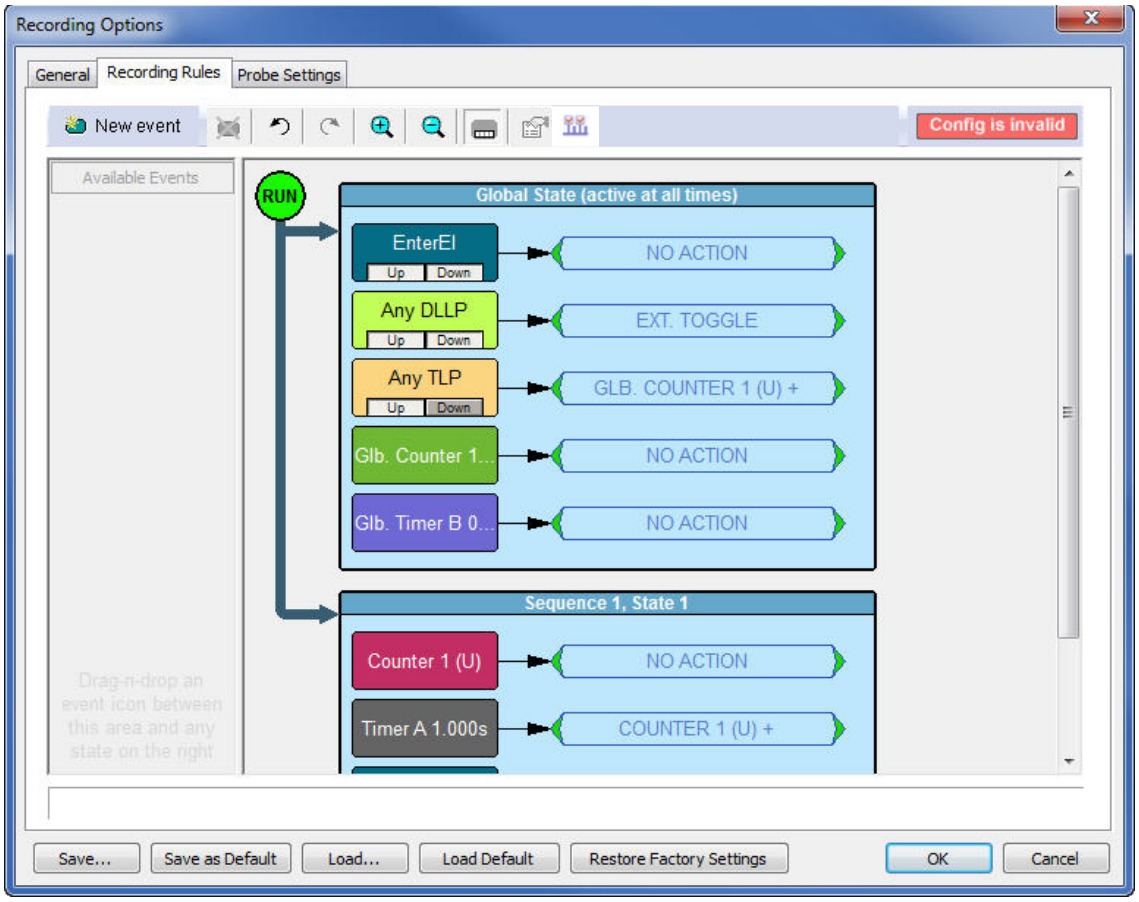


Figure 5.127: Global and Sequence State Timers

As shown in Figure 5.127 on page 355 there is a Global Timer A, set to the value of 1.000s on channel Up displayed in blue in the Global State and there is one timer A, set to the value of 1.000s on channel Down displayed in brown in the Sequence State.

5.14.15.1 How to Set a Timer

Timers are events and you can add a timer to the Global State or the Sequence State as an event by doing the following:

Right-click in the blue space in the Global or Sequence State and **New Event > Timer**.

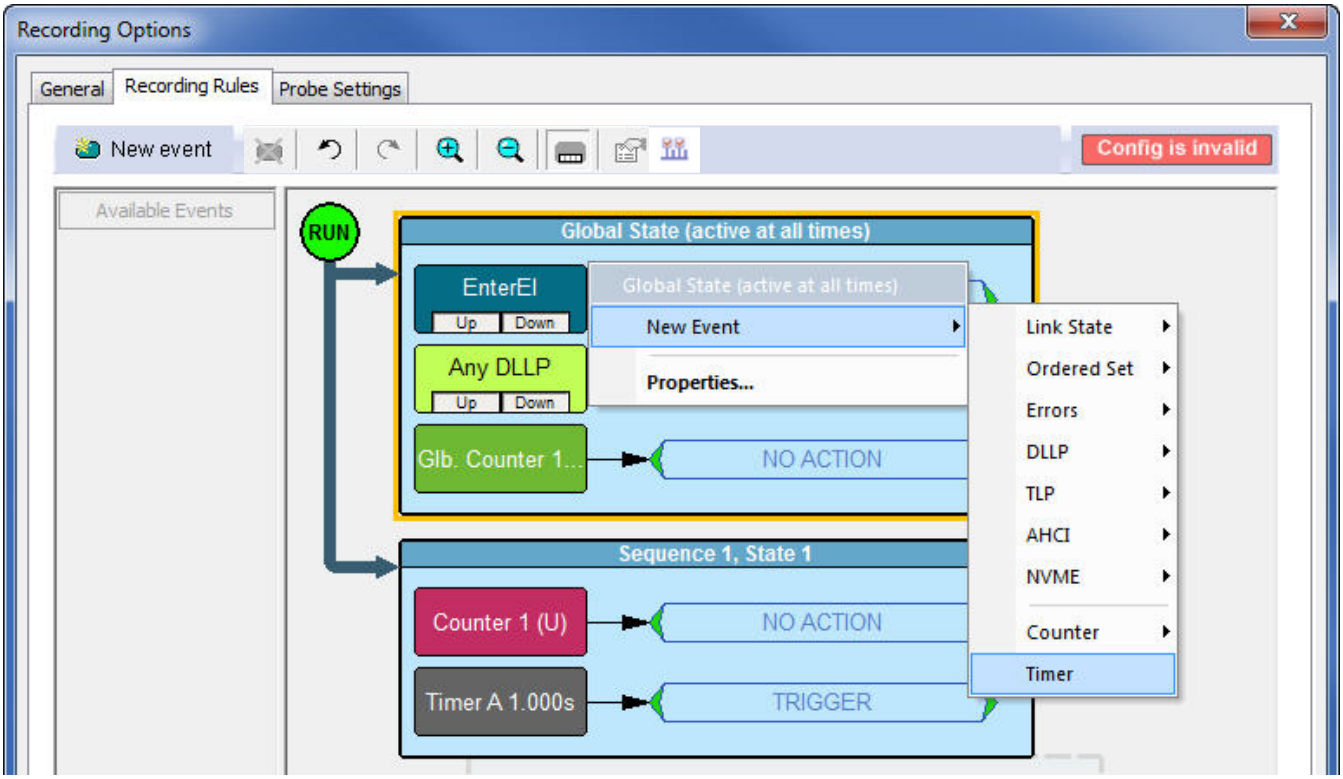


Figure 5.128: Setting Global and Sequence State Timer Events

5.14.15.2 How to Start or Reset a Timer

You can Start or Reset the Timer in the Global State and in the Sequence State by performing the following steps:

1. Open the Recording Rules page, select an event, and drag it to the **Global State** or **Sequence** cells. For details on these steps (see "Events with Channels" on page 359).
2. Right-click on an event and select **Specify Actions > Start Global Timer > Global Timer A** or **Timer B** from the menu (see Figure 5.129 on page 357).

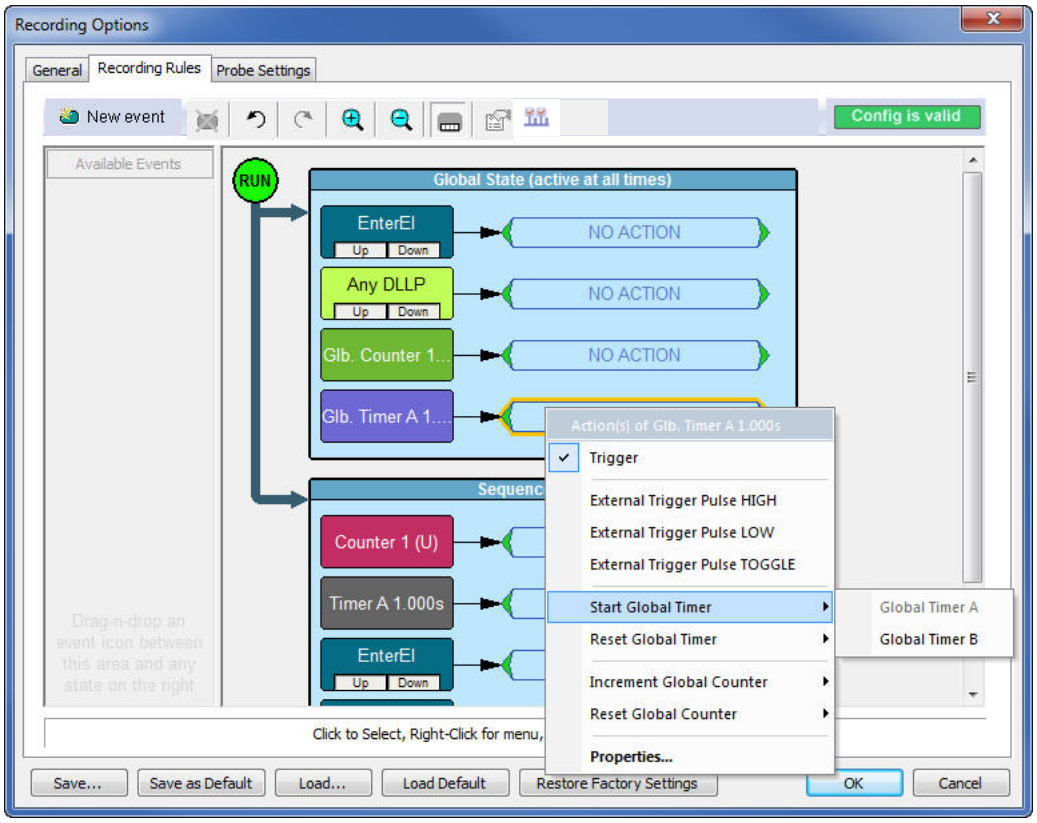


Figure 5.129: Starting and Resetting Global and Sequence State Timers

Note: Listed below are some of the considerations to note about timer functionality

1. If a timer is reset, it will restore to it's original value, in this case the value defined by the user.
2. Resetting a timer will stop it and set it to it's original value.
3. Local timers for a particular state will automatically reset if the sequencer advances to another state. Example: "Timer A" in State 1 and "Timer A" in State 2 are different timers not related to each other.
4. Local timers are controlled by events defined in the same state where the timers are defined.
5. In case of competing actions to control global timers using the same event from global and local states, the control from local states takes priority.

5.14.15.3 Changing the Value of the Timer

To change the value of the timer (see Figure 5.130 on page 358):

1. Right-click on the Timer.
2. Select **Properties**
3. Enter in values for the Timer in the fields provides in Secs, Millisecs, Microsecs and Nanosecs on the Timer tab. After selecting the options you want click on the “OK” button.

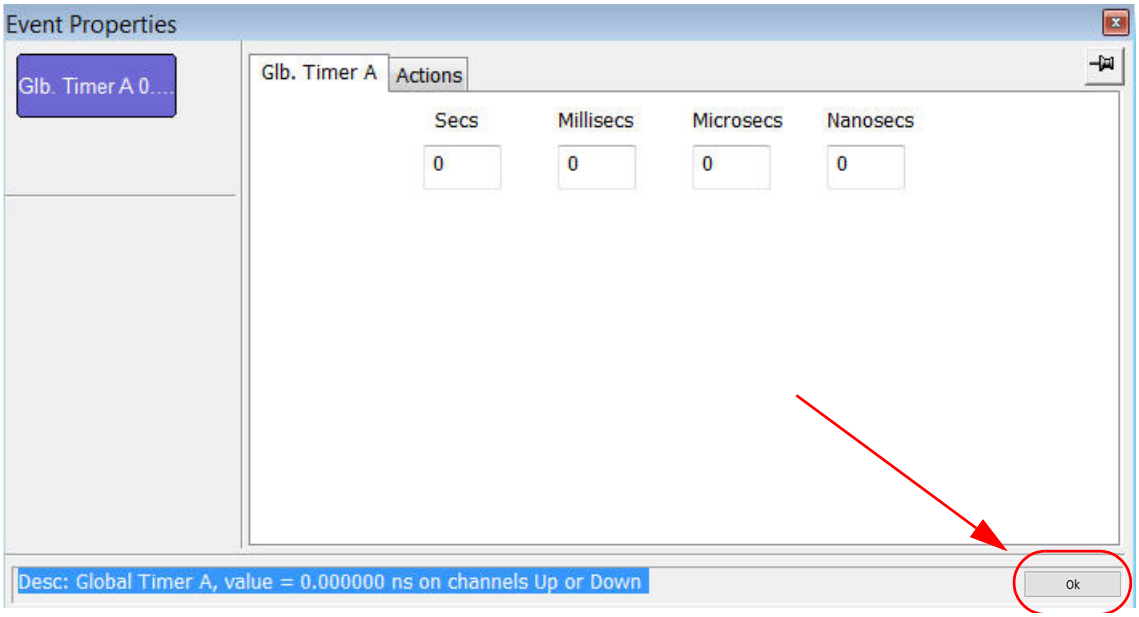


Figure 5.130: Setting the Timer Values

4. Click on the Actions tab and set the External and Internal Triggering, Sequencing and Filtering options. You can label the timer.

5.14.15.4 Deleting a Timer

To delete a Timer

1. Right-click on the Timer.
2. Select **Delete This Event.** The Timer will disappear from the event.

5.14.16 Channel

Every event has two channels, one upstream and the other downstream. You can use both channels with any event. The channels are independent of each other. If both channels are selected it is valid but no action occurs, and thus no timer and counter is created. Figure 5.131 shows three events in the Global State, the first event is on Channel Up and the 3rd event is on Channel Down.

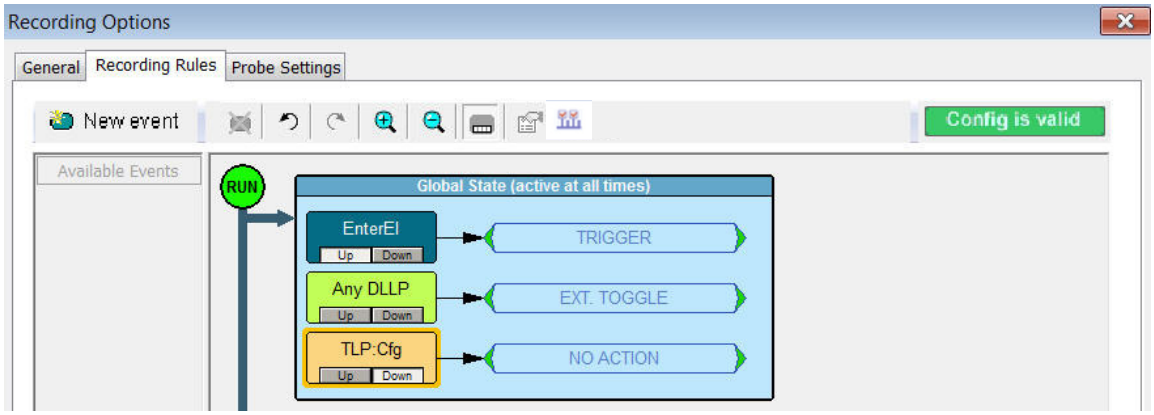


Figure 5.131: Events with Channels

5.15 Probe Settings

The Summit T3-16, T3-8, T34, T28 and T24 analyzers can be optimized for specific DUT signal characteristics. The auto calibration feature in the Probe Settings allows for better signal recovery. There are 16, 0 db to 15 db, internal equalization modes in the analyzer hardware that boost the high frequency content of the captured signal. This equalization does not impact the signal to the DUTs, but helps in 'opening the eye' of the captured signal, so that the internal logic can capture PCIe frames. The system is designed to allow you to manually set the equalization to one of the sixteen modes for the CTLE values and one of the eight modes for the DFE values or choose to run an automated algorithm, internal to the analyzer. This automated calibration sets the optimized values for each of the PCIe captured lanes, provided that the signal at the analyzer input is stable.

5.15.1 Lane Settings for Gen3 Analyzers: T3-16, T3-8 and T34

Each lane can be configured to use specific equalization settings to match signal characteristics of the lane and improve the analyzer's ability to capture error free traces. For 2.5/5.0 GT/s speeds only CTLE setting is required to achieve good captures. For 8.0 GT/s you can adjust CTLE, DFE and DC Gain parameters.

5.15.2 Lane Settings for Gen2 Analyzers: T28 and T24

Two lane settings can be configured, CTLE and DFE (Decision Feedback Equalization). CTLE is two dimensional and is set based on the least number of errors returned. DFE is three dimensional and is set based on the least number of errors returned by both CTLE and DFE.

Setup Menu

Select **Recording Options > Probe Settings** from the **Setup** menu to display Probe Settings**.** There is a tooltip to help explain the Probe Settings Menu as shown in Figure 5.132 on page 361.

Setting Auto Calibration

The Probe Settings tab in the Recording Options dialog displays the equalizer settings. To set all lanes upstream and downstream check the **Set All Lanes** box**.** Click on **Auto Calibration** (see Figure 5.132 on page 361) to display the **Calibrate** dialog (see Figure 5.134 on page 362). The Menus shown below are for the Summit T3-16 analyzer.

The Summit T3-8, T34, T28 and T24 are similar Menus but vary with the number of lanes to be calibrated and the transfer rate (GT/s) but the concepts are the same.

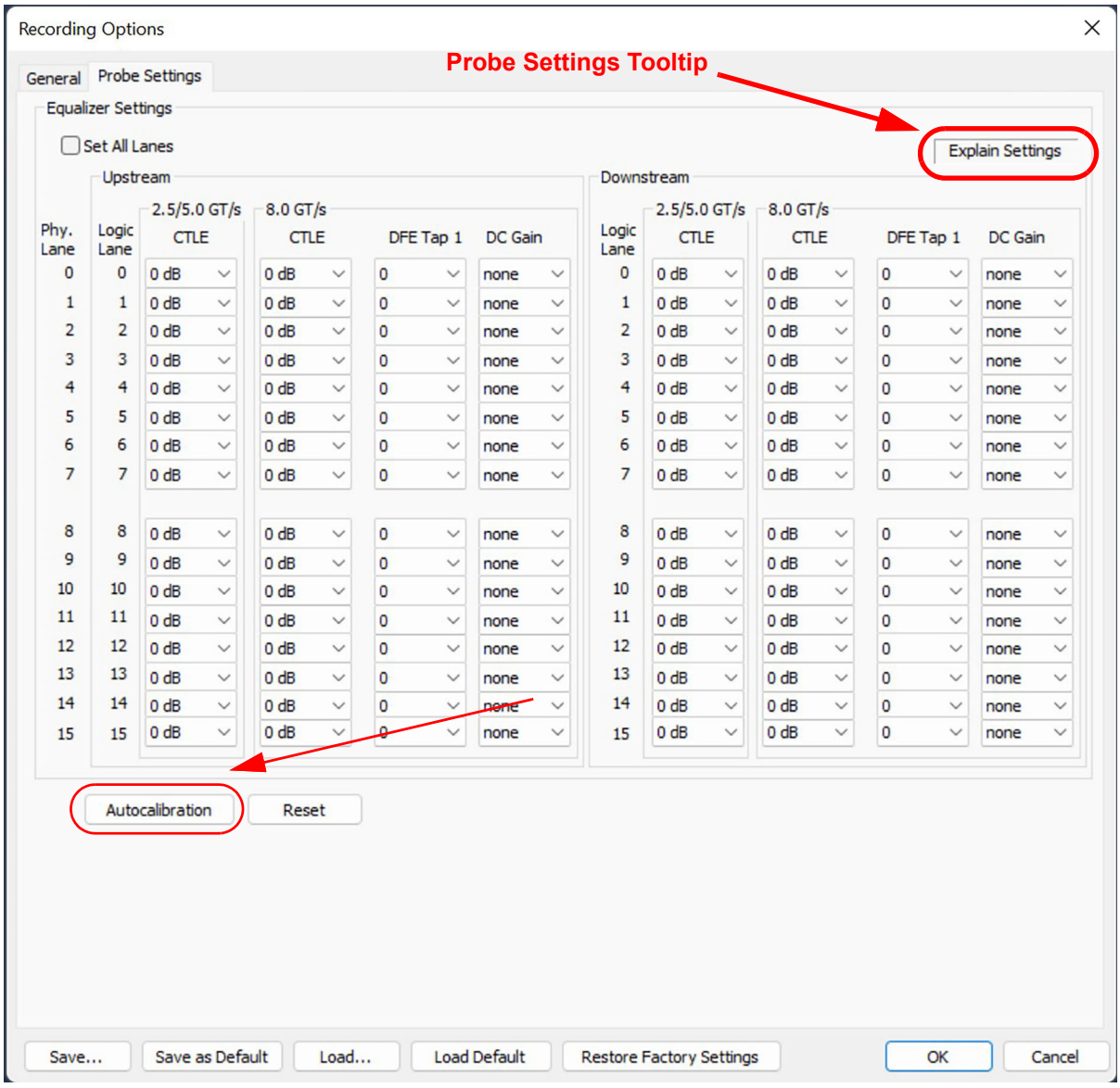


Figure 5.132: Probe Settings Tab

The Summit analyzers can be optimized for specific device-under-test signal characteristics. There are sixteen internal equalization modes in the analyzer hardware, 0 dB to 15 dB, that boost the high-frequency content of the captured signal. This equalization does not impact the signal to the DUTs, but can help in 'opening the eye' of the captured signal, so the internal logic can capture the PCIe frames. The system is designed as such so you can manually set the equalization to one of the sixteen modes or choose to run an automatic algorithm, internal to the analyzer. The automate calibration would set the optimized values to each of the PCIe captured lanes, provided that the signal at the analyzer input is stable.

Figure 5.133: Probe Settings: Tooltip

You can auto calibrate the probe settings by clicking on the Auto Calibration button. In

order to calibrate the device the link should be trained to the widest width and the highest speed. Specify the link width, speed, individual lanes to be calibrated and lane polarity. Click **Start Calibration** (see Figure 5.134 on page 362)**.** By default, the polarity settings are carried over from the recording options menu.

To use the external reference clock or for quick calibration click the appropriate checkboxes to select them. If checked, calibration routine will only scan CTLE, if not checked it will include DFE with the CTLE scan which will take longer, approximately 9 minutes.

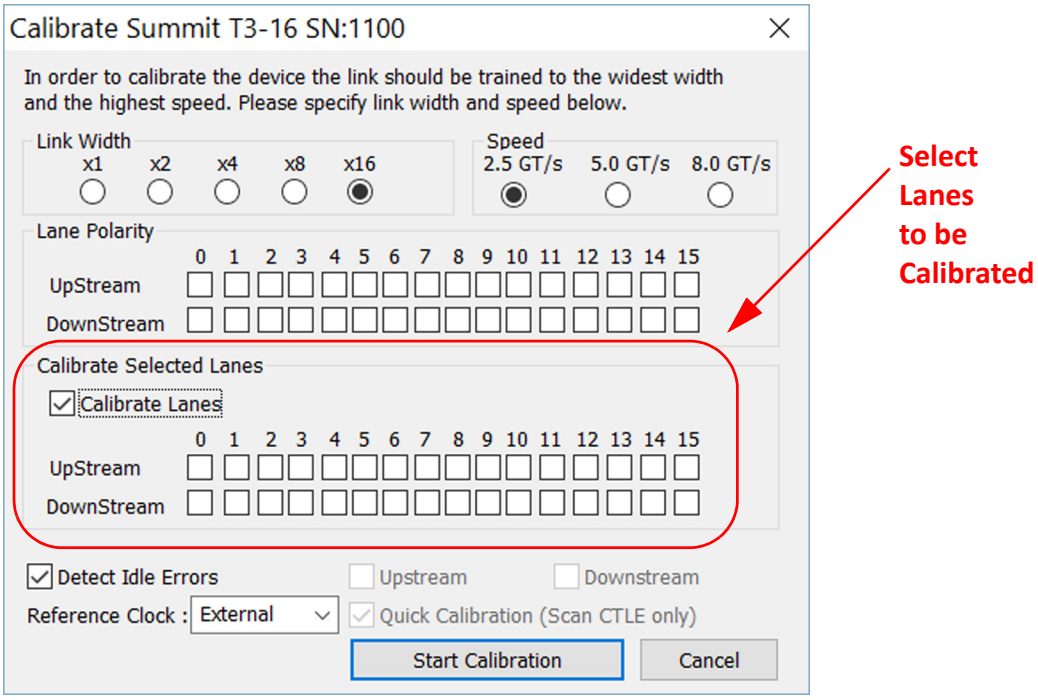


Figure 5.134: Calibrate Dialog

The calculated CTLE values are automatically displayed in the relevant lane field. Click **Save** to save the settings or click **Save As Default** to save the settings as the default. Click **Load** to save the settings as a .rec file as a PCIe Protocol Analysis Recording option to be used at a later time. Click **Reset** to clear the settings.

The calculated CTLE values are automatically displayed in the relevant lane fields as shown in Figure 5.135. Click **Save** to save the settings or click **Save As Default** to save the settings as the default. Click **Load** to save the settings as a .rec file as a PCIe Protocol Analysis Recording option to be used at a later time. Click **Reset** to clear the settings (see Figure 5.135 on page 363).

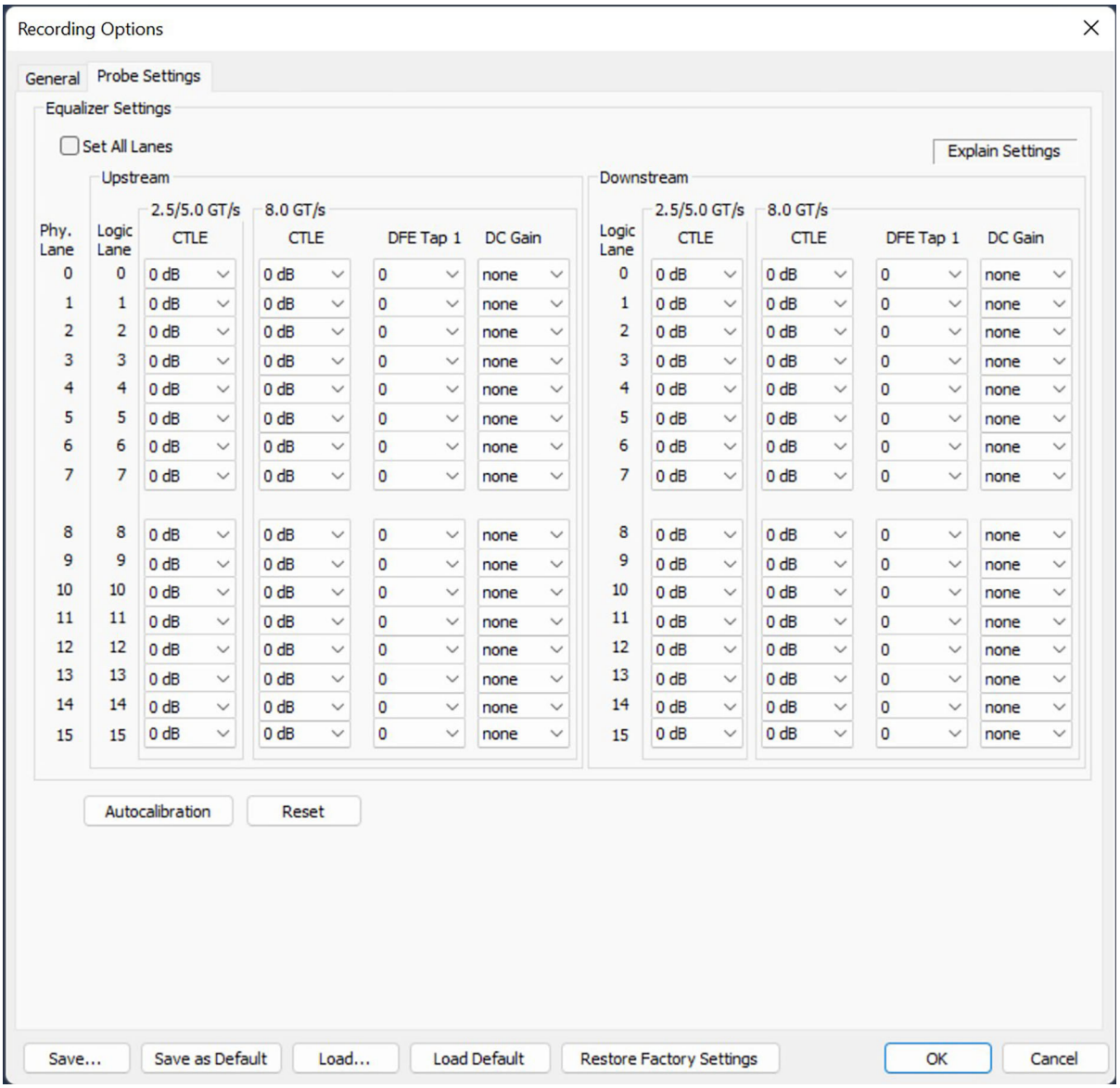


Figure 5.135: Auto Calibration Settings

5.15.3 PCIe Gen3 Auto Calibration

In order for auto calibration at Gen3 to work, lane polarity has to be set manually. In general, follow the steps below to find the polarity and set it up properly in the calibration dialog.

1. Setup the analyzer to record the training sequence with (TS2, Switch to G3 or InitFC1), at Gen1 or Gen2 (use trigger as TS2 or Speed Switch), using the Auto-Configure Lane Polarity recording option. This will allow the analyzer to calculate/ determine the polarity and lane reversal settings of the link.

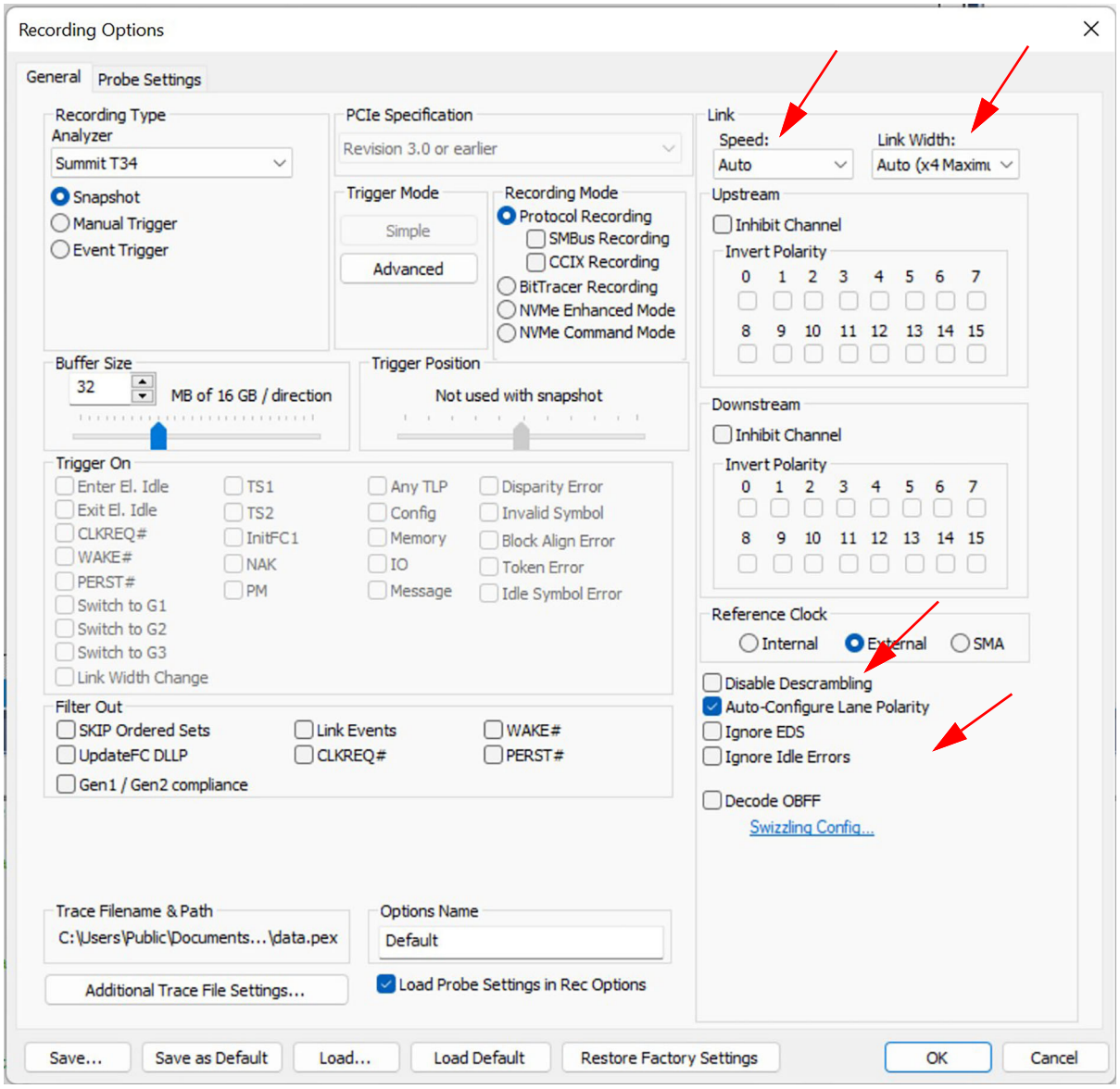


Figure 5.136: Simple Mode Tab

2. Drive the link to Detect or Recovery by powering up or booting the system.

3. After the recording is complete, click the Dashboard View icon to open the Dashboard dialog and verify the polarity calculated by the analyzer (see Figure 5.137 on page 364).

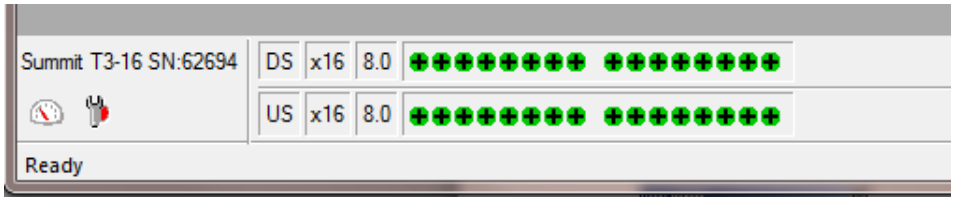


Figure 5.137: Dashboard View

Note: You can also set the recording option for auto configure lane polarity to unchecked and set up the polarity manually after reviewing the training sequences shown in the CATC Trace (refer to http://cdn.teledynelecroy.com/files/appnotes/lane_reversal_and_polarity.pdf). In this case, do not open the Dashboard dialog and go directly to step 6.

4. Copy the calculated polarity from the Dashboard to the Recording Options by clicking the **Copy Polarity Settings to Recording Options** button.

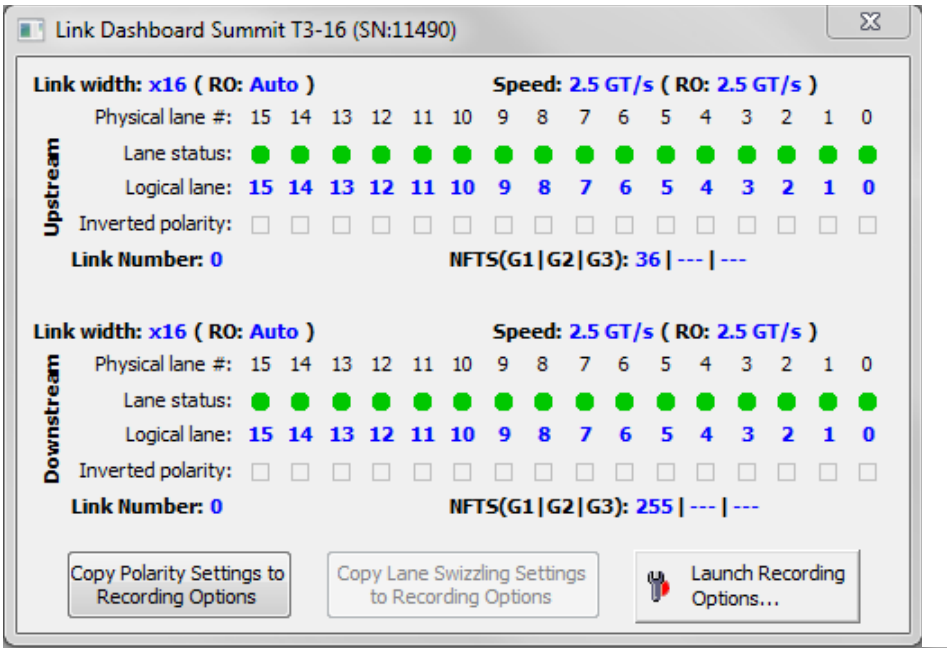


Figure 5.138: Calculating Optimal CTLE Progress Bar

5. Close the Dashboard and verify that the lane polarity in Recording Options have been updated. You will need to keep using this configuration after the calibration has been performed.
6. Drive the link to Gen3 and make sure the link stays in Gen3 L0 (no low power states or speed switch).
7. Select **Recording Options** and click the **Probe Settings** tab.
8. Click **Auto Calibration** to display the Calibrate SummitT3-16 Dialog.
9. Manually set the polarity for each lane in this dialog with the polarity settings in the Link Dashboard. Link Width, Speed, Individual Lanes to be Calibrated and Polarity must be set the same as the current state of the link. Checking the Quick Calibration option will sweep through the CTLE setting only. If unchecked it will sweep through both CTLE and DFE. Using Detect Idle Errors will increase the calibration time but it will improve/optimize calibration results.

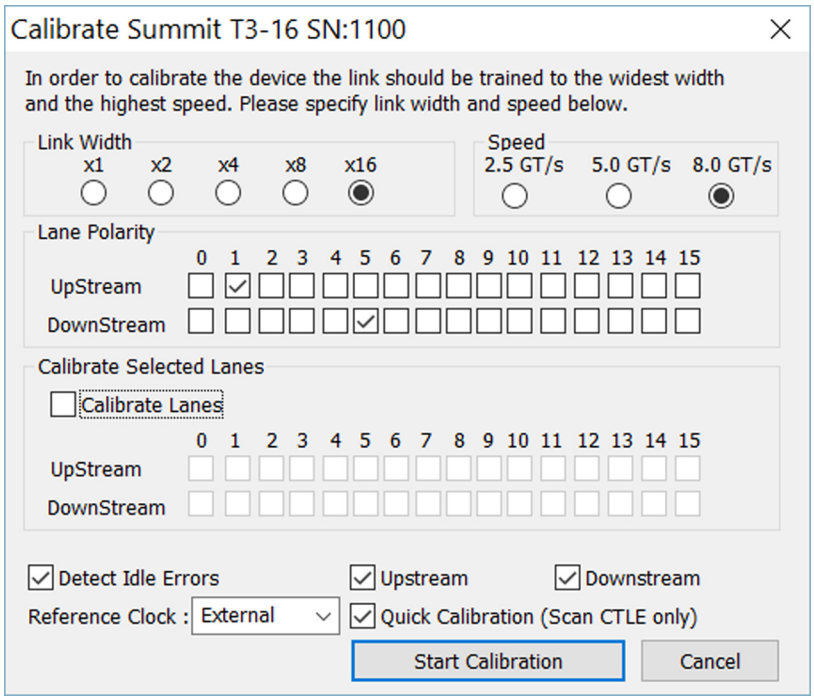


Figure 5.139: Calibrate Summit T3-16 Dialog

10. Click **Start Calibration**.
11. On completion of calibration, close the Auto Calibration dialog.

    It may take 10-20 minutes for x8 and upwards 45 minutes to calibrate an X16 link for both directions with Detect Idle Errors checked and Quick Calibration unchecked.
12. Start recording at Gen3 speed using the Recording Option Speed set to Gen3 or Auto.

5.15.4 Save

The Save function in the Recording Rules and the Probe settings tab has the following options (see Figure 5.140 on page 367):

- General Recording (**.rec** extension): A general recording options file which contains settings from the ‘General(Tab)’, ‘Recording Rules’ and ‘Analyzer Calibration’ tabs
- Recording Options in XML format (**.xrec** extension): Recording options file which contains settings from the ‘General’, ‘Recording Rules’ and ‘Analyzer Calibration’ tabs in XML format.
- Probe Settings (**.ps** extension): See “Probe Settings” on page 360.

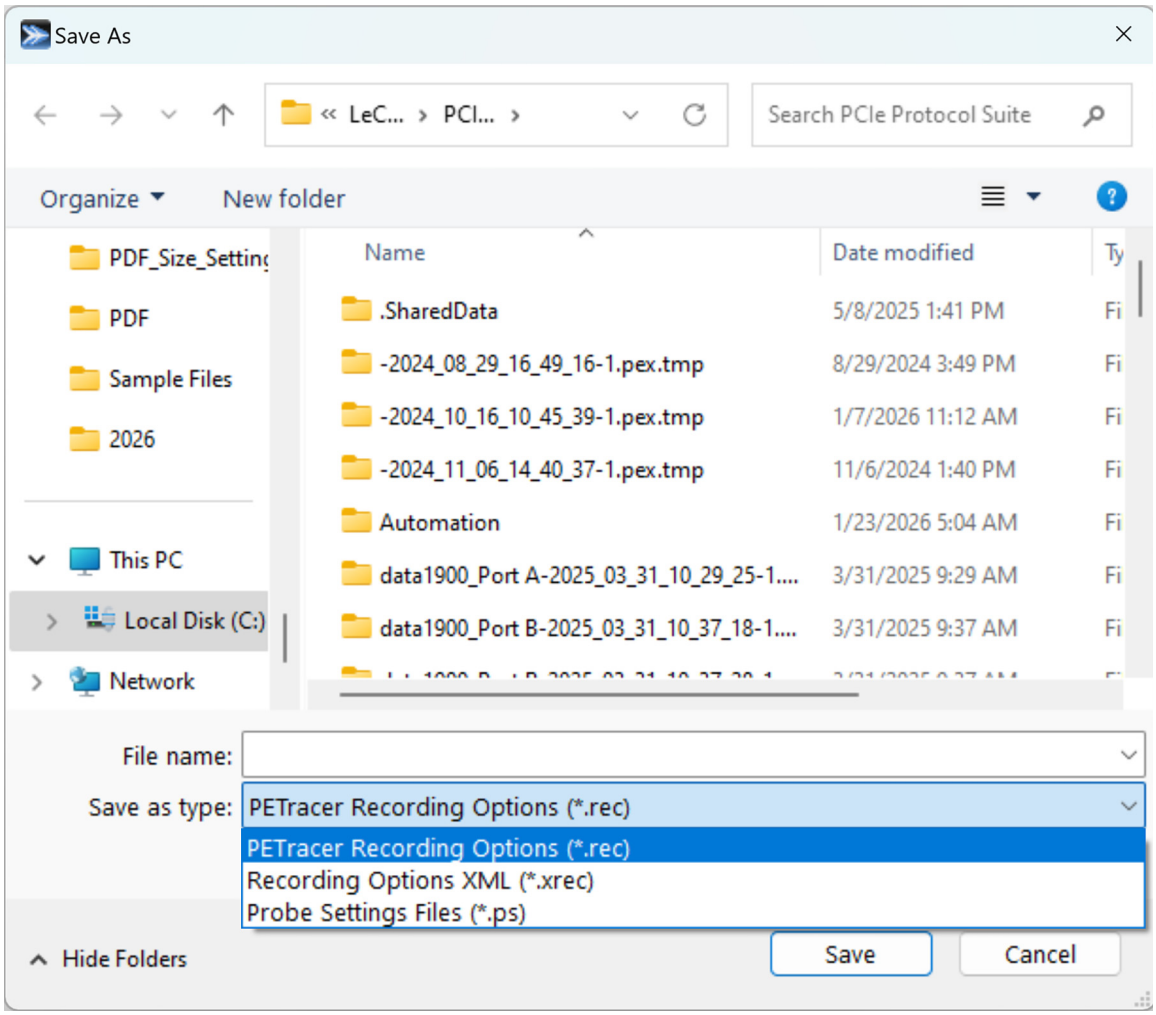


Figure 5.140: Save Dialog

5.15.5 Load

The Load function in the Recording Rules and the Probe settings tab has the following options (see Figure 5.141 on page 368):

- General Recording (**.rec** extension): A general recording options file which contains settings from the 'General(Tab)', 'Recording Rules' and 'Analyzer Calibration' tabs.
- PCIe Trace Files (**.pex**): Load the Recording Options of PCIe Trace Files
- Recording Options in XML format (**.xrec** extension): Recording options file which contains settings from the 'General', 'Recording Rules' and 'Analyzer Calibration' tabs in XML format.
- Probe Settings (**.ps** extension): See "Probe Settings" on page 360.

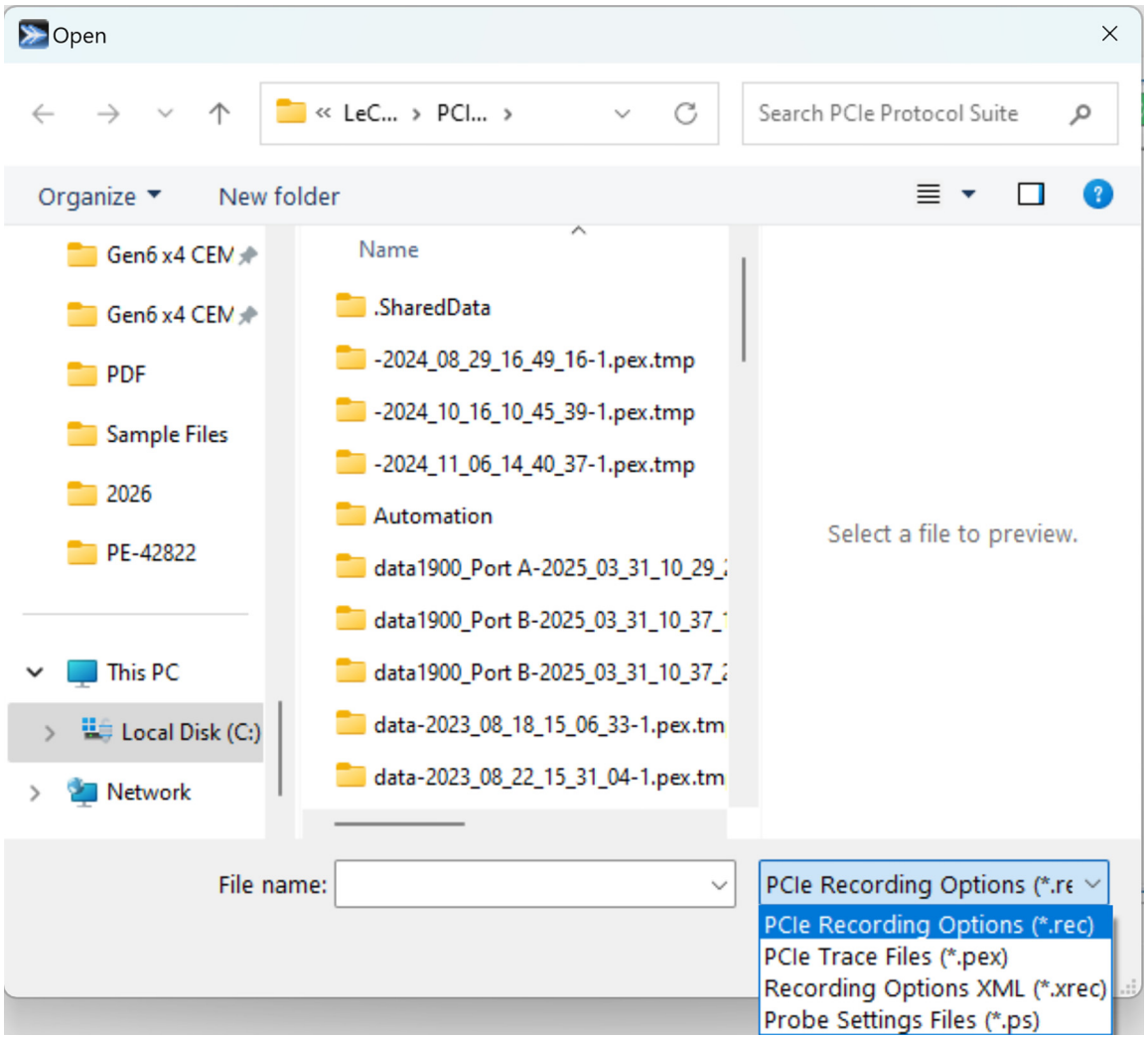


Figure 5.141: Load Dialog

5.16 NVMe Enhanced Recording Mode: Summit T34 Only

NVMe Enhanced Recording Mode is a feature currently only available in Summit T34 that allows for longer recording time of NVMe transactions.

Note: NVMe Enhanced recording mode is possible in Expanded mode but limited up to x4.

5.16.1 Preparing to Record in NVMe Enhanced Mode

Several prerequisite steps are required to ensure the system is configured properly for recording in NVMe enhanced mode. A PCI Protocol recording should be taken in L0 to determine that all the PCIe link parameters are selected correctly to record without errors. Once that is done the link parameters should not be changed for later recordings.

Secondly, a PCIe protocol recording should be taken of the complete power up and connection sequence between the NVMe device and host. This boot recording is required to map all of the configuration registers, devices, submission and completion command queues and other resources to the correct address spaces. These mappings will be used automatically by NVMe Enhanced Mode to create a set of filters to only filter in and record traffic from the correct set of devices and resources.

A boot recording will be automatically recognized by the software and saved for later sessions. It is recommended to capture a new boot recording for each session because resources can be created and deleted in the gap between a boot recording and an NVMe Enhanced Mode recording and those resources created in the interim will not be recognized correctly.

There are three separate methods to use the NVMe Enhanced Recording Mode.

- Snapshot – Simple Mode
- Snapshot – Advanced Mode
- Event Trigger – Advanced Mode

The simplest is the Snapshot in Simple mode as described below.

5.16.2 Snapshot - Simple Mode

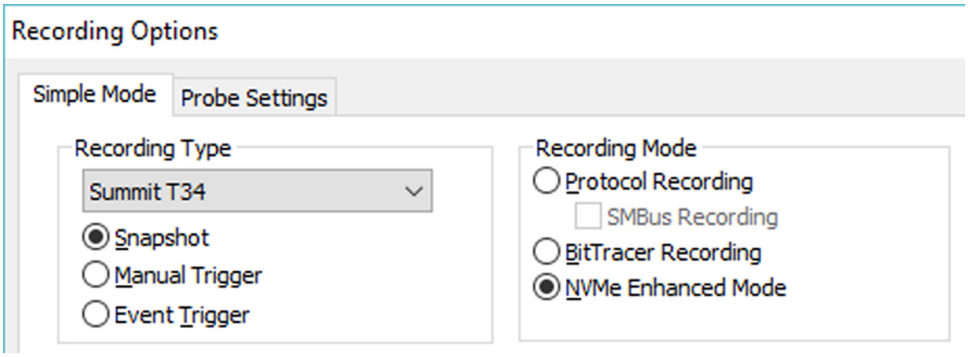


Figure 5.142: NVMe Enhanced Recording Mode

When the NVMe Enhanced Mode button is selected the following warning will popup in

the Recording Panel (under NVMe Device ID#) if an SSD Device Configuration File has not been stored. To generate and store an SSD Device Configuration File is a two step process:

- First record a boot trace
  (see http://teledynelecroy.com/doc/capture-of-an-nvme-boot-up-trace-appnote)
- Second, Export the SSD Device Configuration File

5.16.2.1 Features

NVMe Enhanced Recording Mode allows filtering of all traffic except the exact traffic desired by the user. This will extend the potential recording depth to millions of commands and allow recording over time intervals that were previously impossible.

Simple recording mode is shown below (Figure 5.143) and shows the available resources to filter in: NVMe Commands, Doorbells, Controller Registers, MSI interrupts, ACKs and Device Config, along with all the available devices detected in the boot recording. Selecting a check box will include that type of traffic in the recording.

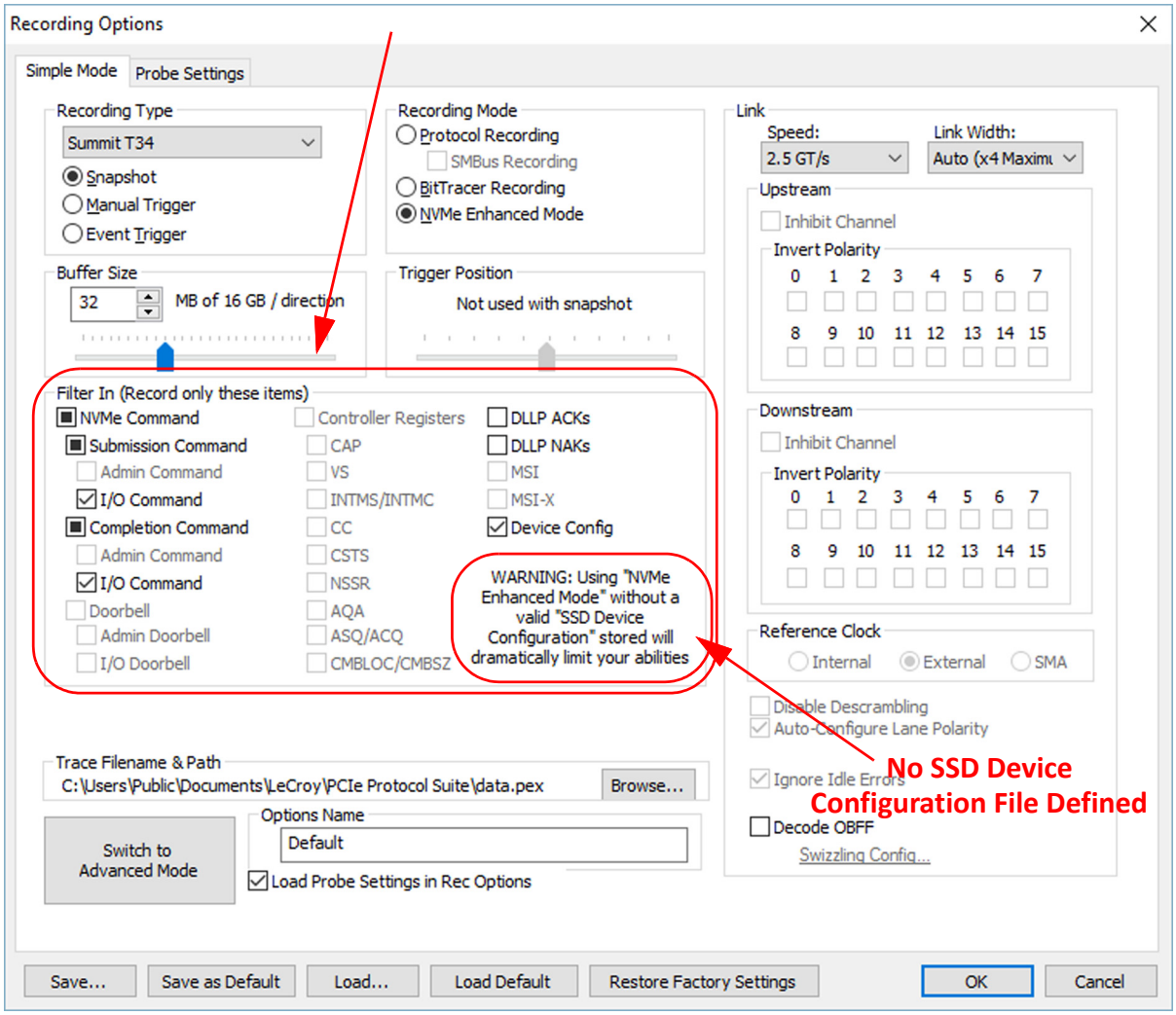


Figure 5.143: NVMe Enhanced Recording Mode: Snapshot - Simple Mode, Device not Defined

If you had defined a valid SSD Device Configuration the Recording Menu would display

the device under test. See Figure 5.144 on page 371. A sample SSD Device Configuration file is shown in "SSD Device Configuration File" on page 377.

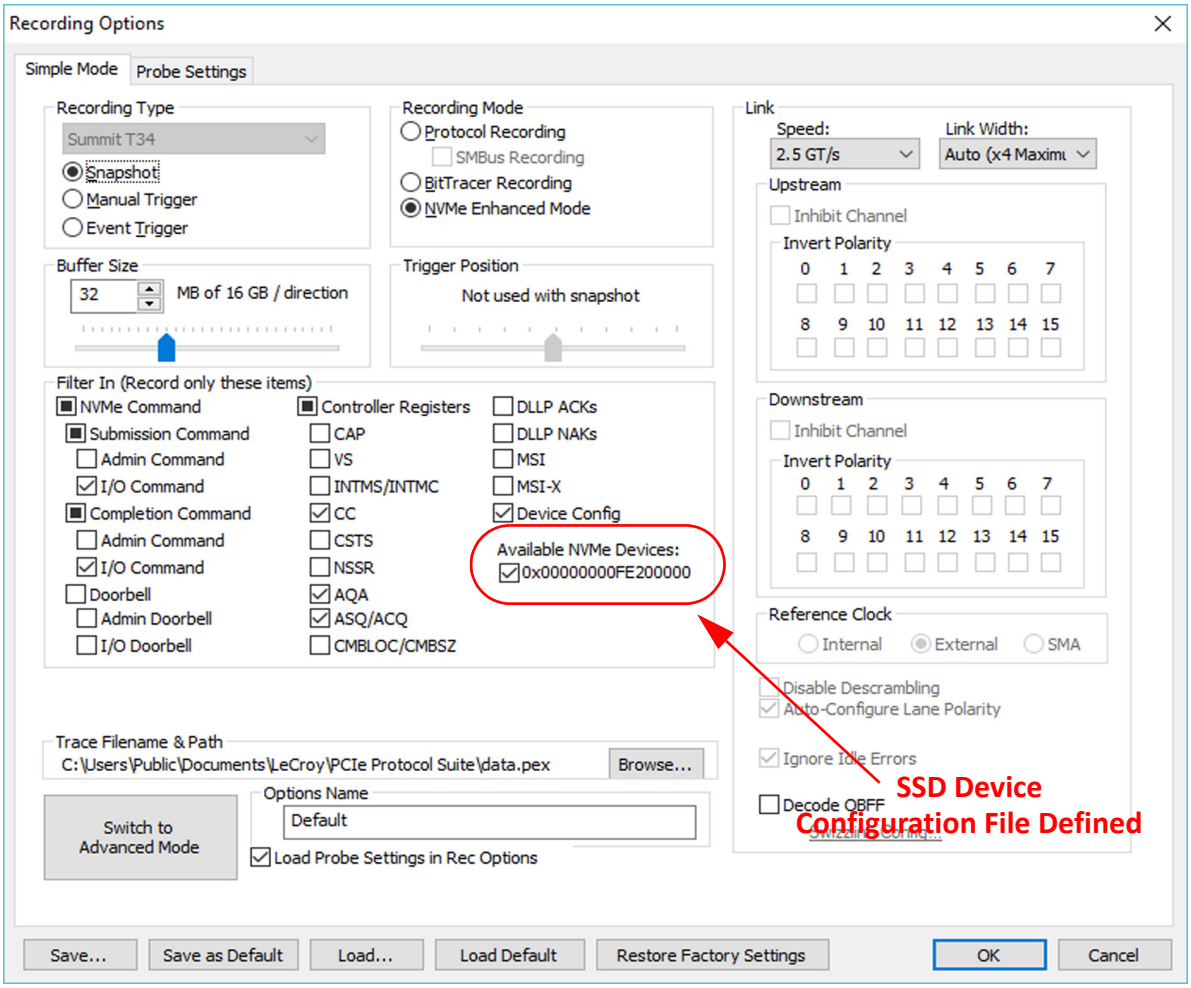


Figure 5.144: NVMe Enhanced Recording Mode: Snapshot - Simple Mode, Device Defined

Note: If you try and go to Event Trigger - Simple mode the following warning message pops up:

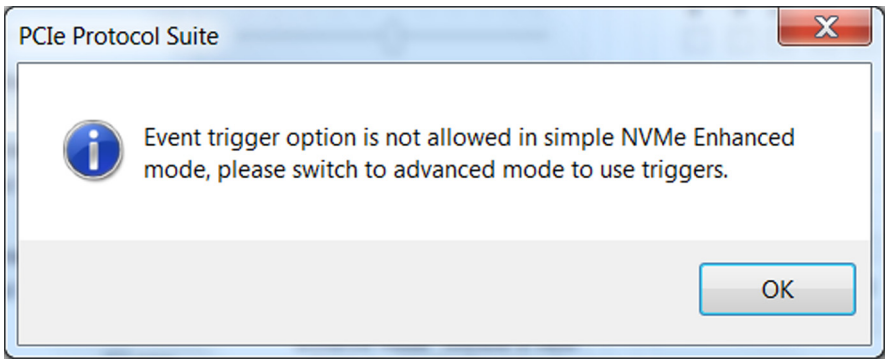


Figure 5.145: NVMe Enhanced Mode: Event Trigger - Simple Mode

5.16.3 Snapshot - Advanced Mode

The General options in Snapshot - Advanced Mode are shown below:

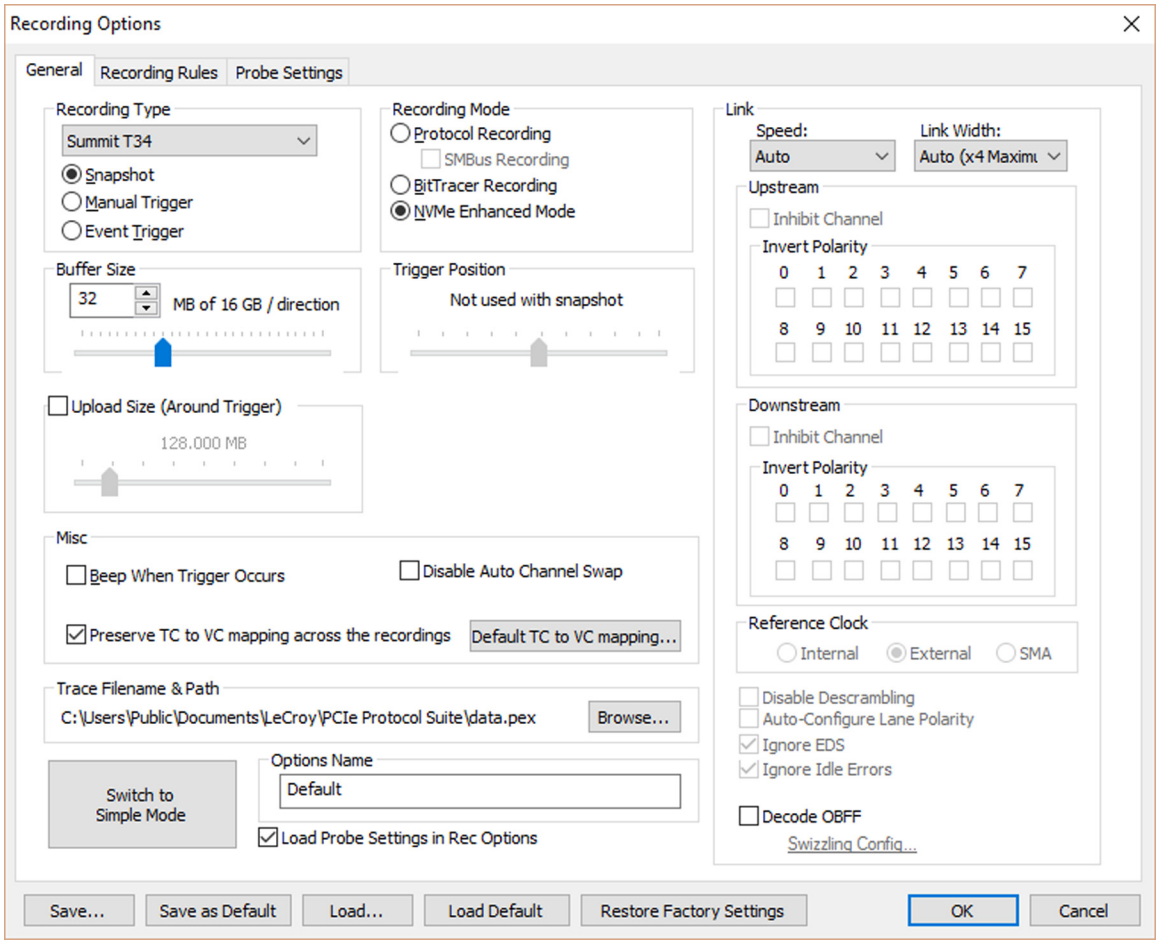


Figure 5.146: NVMe Enhanced Mode: Snapshot-Advanced Mode

Open the Recording Rules to see that an NVMe Enhanced Mode Event has been automatically added to the Recording Rules (see Figure 5.147 on page 373).

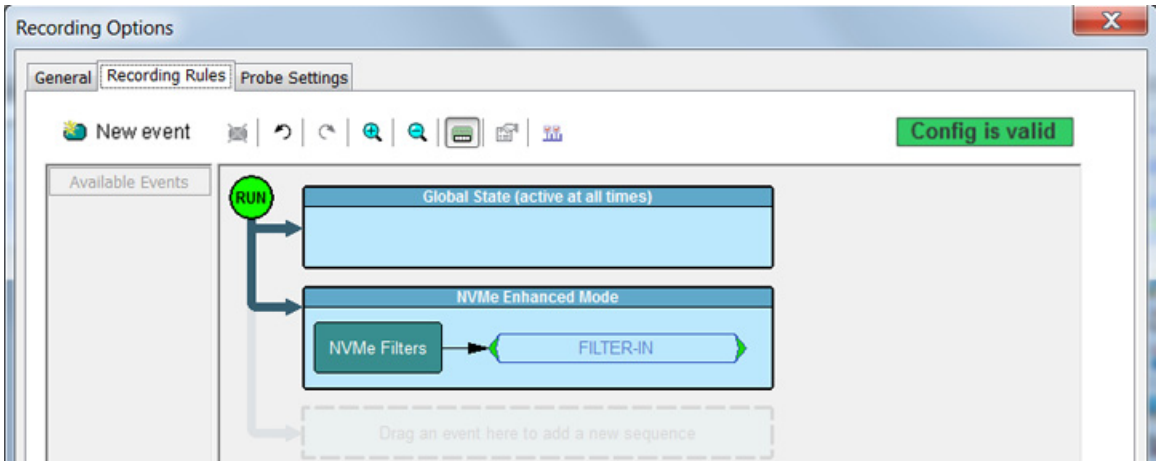


Figure 5.147: NVMe Enhanced Mode: NVMe Filters Event Added

Select the NVMe Filters box to bring up the following dialog. After selecting the options you want click on the “OK” button.

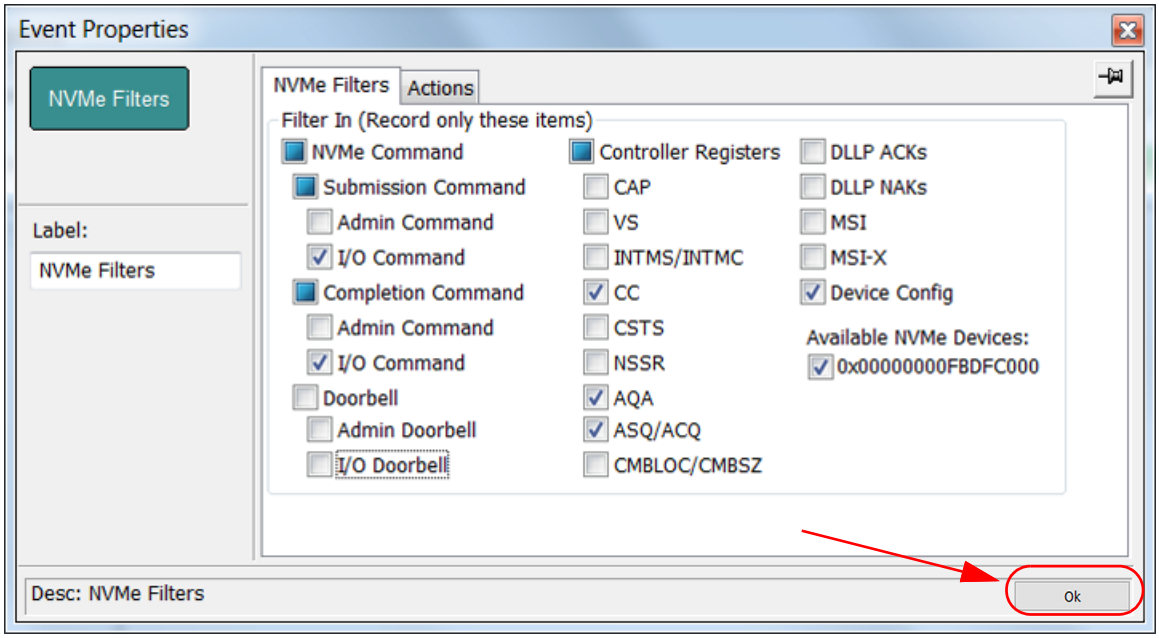


Figure 5.148: NVMe Enhanced Mode: NVMe Filters

Note: No Actions are available at this time.

5.16.4 Event Trigger - Advanced Mode

Changing to Event Trigger -> Advanced Mode will pop up the following dialog. See Figure 5.149.

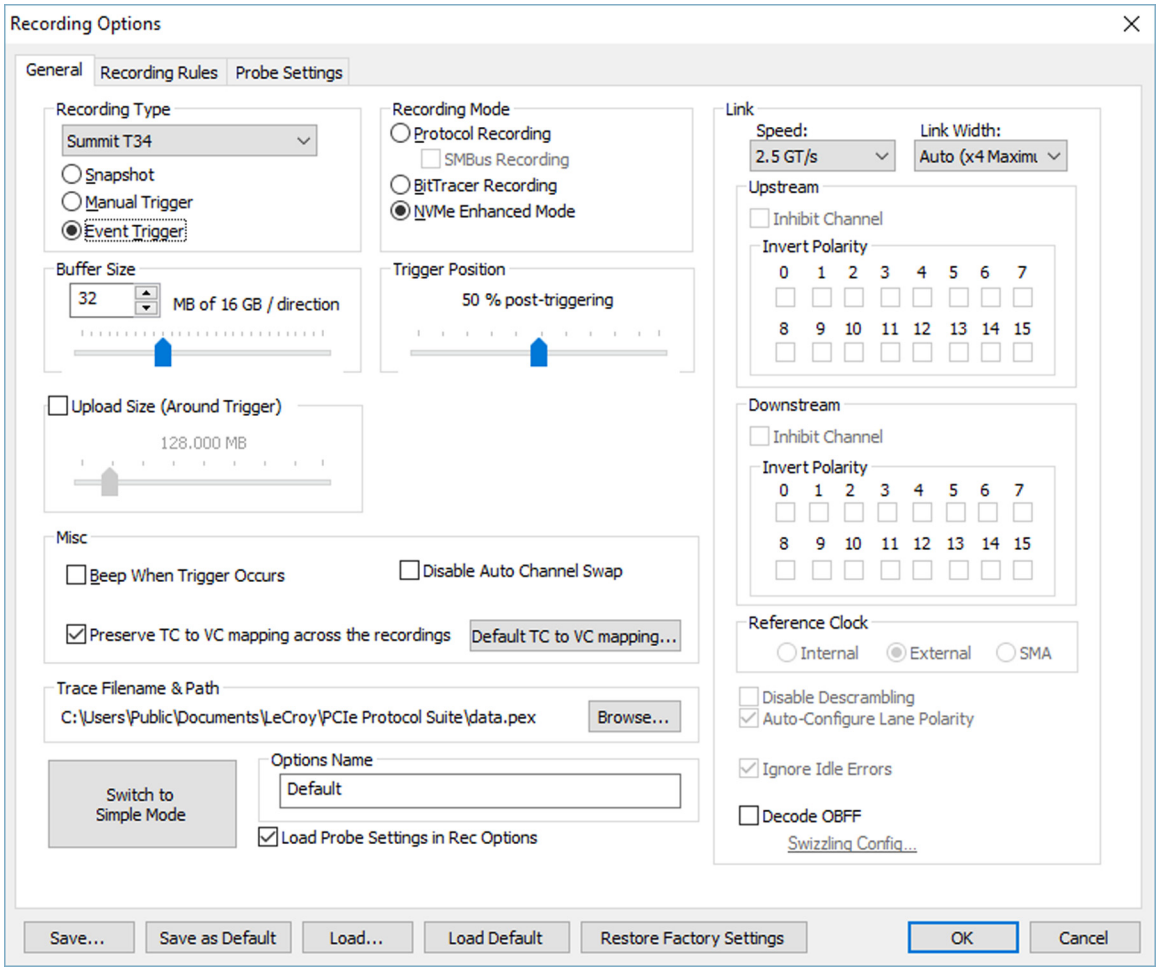


Figure 5.149: NVMe Enhanced Recording: Event Triggered - Advanced Mode

Selecting Recording Rules will pop up the same warning message if a boot trace and SSD Device Configuration File have not been generated (see Figure 5.143 on page 370).

The next step is to continue defining your Recording Rules:

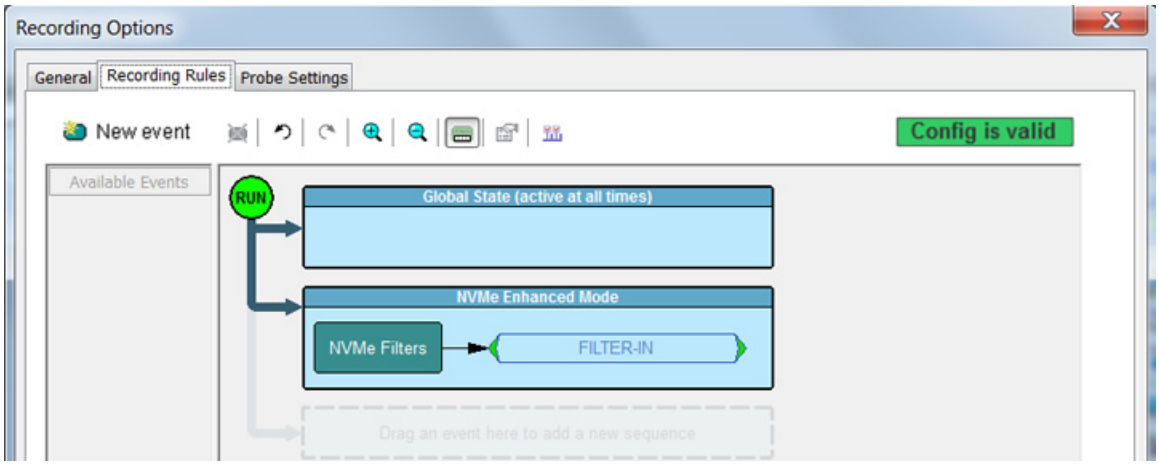


Figure 5.150: NVMe Enhanced Recording Mode: Defining Recording Rules

The NVMe Filters in Enhanced Mode are the same in both Snapshot - Advanced Mode and Triggered Event - Advanced Mode: See Figure 5.151 on page 375. After selecting the options you want click on the “OK” button.

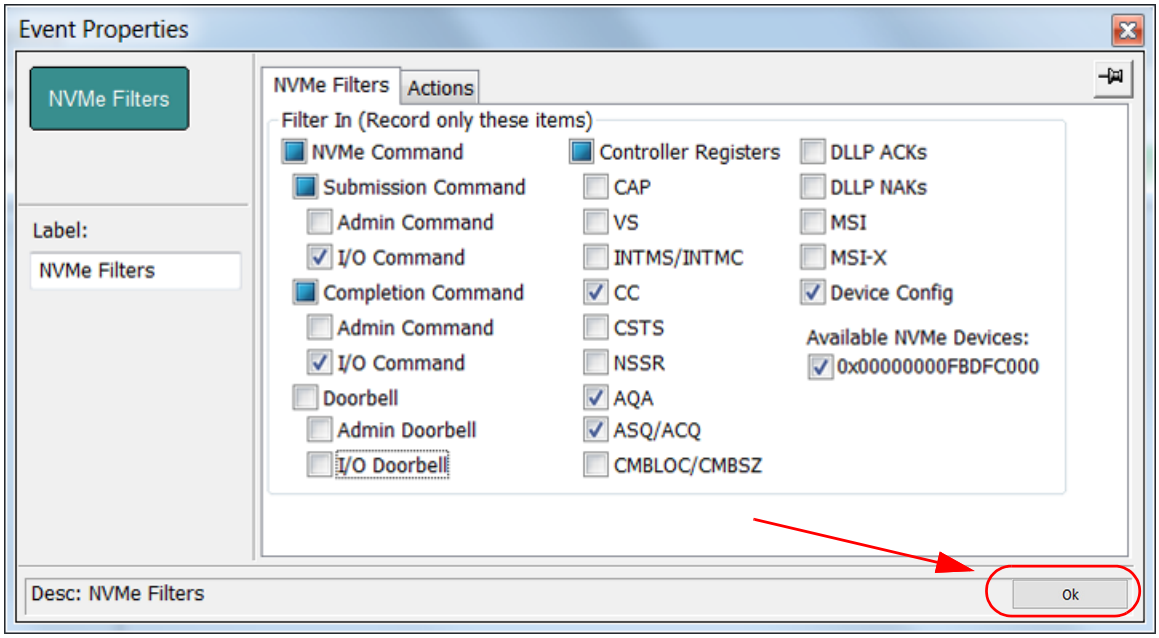


Figure 5.151: Triggered Event - Advanced Mode: Filter Options

Note: No Actions are available at this time.

Now that you have the NVMe Enhanced Mode/NVMe Filters in place, you can continue refining your triggering criteria and then start recording data.

Note: If you try and return to Event Trigger - Simple mode, the GUI automatically changes to Simple Mode - Snapshot, see Figure 5.152 on page 376.

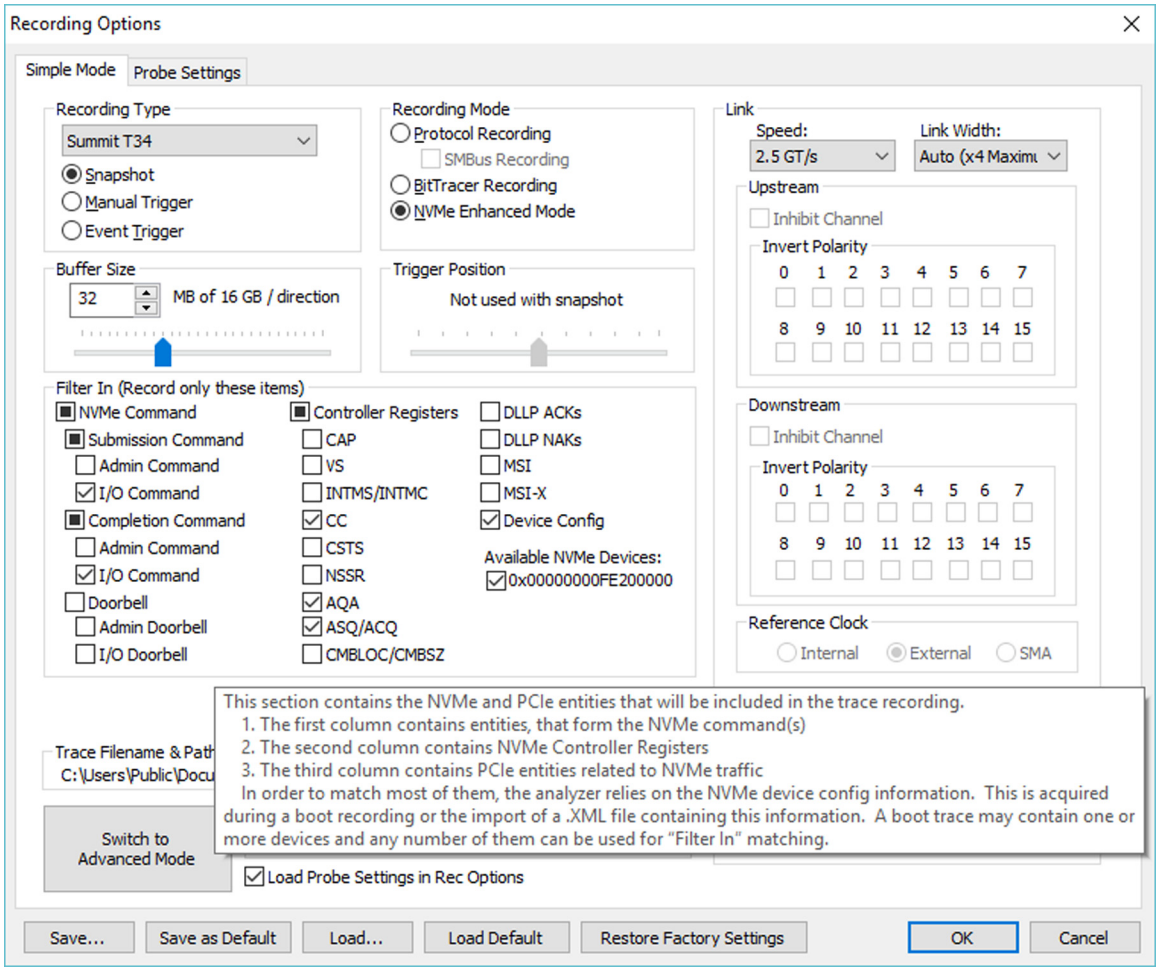


Figure 5.152: NVMe Enhanced Mode: Simple Mode - Snapshot

5.16.5 SSD Device Configuration File

As explained earlier in “Preparing to Record in NVMe Enhanced Mode” on page 369 an XML file is one way to enable the analyzer to run in NVMe Enhanced Mode. A typical XML file, which works in both Simple and Advanced Mode is shown below:

This XML file is located at:
C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\Temp directory.

<?xml version="1.0"?>

<DEVICES XML_FORMAT_VERSION="1.0"><DEVICE GUID="{1B105360-2808-4A07-AFE4-AF49F1D61CC6}" ENABLE="0x1" DEVICEID="006:00:0" VENDORID="0" CLASSCODE="67586" DEVICENAME="" TRANSACTION_LIFETIME_NS="0">

<BARS><MBAR ID="0" VALUE="0xFBDFC000"/><BAR ID="2" VALUE="0x00000000"/><BAR ID="3" VALUE="0x00000000"/><BAR ID="4" VALUE="0x00000000"/><BAR ID="5" VALUE="0x00000000"/></BARS>

<PROTOCOL IOSQES="6" MQES="64" ASQS="127" PROTOCOL="NVME" ACQS="127" DSTRD="4" IOCQES="4" LBASIZE="512" MPS="4096"/><Queues><Queue IR_VECTOR="0" ADDRESS="0x23F3BC000" SIZE="64" QID="0" IR_ENABLED="0" TYPE="ASQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E641000" SIZE="1024" QID="8" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E76D000" SIZE="1024" QID="11" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E7D1000" SIZE="1024" QID="12" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F143000" SIZE="1024" QID="4" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E6A5000" SIZE="1024" QID="9" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E709000" SIZE="1024" QID="10" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F07B000" SIZE="1024" QID="2" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F1A7000" SIZE="1024" QID="5" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23EFCB000" SIZE="1024" QID="7" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F1CA000" SIZE="1024" QID="6" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F0DF000" SIZE="1024" QID="3" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F3DD000" SIZE="1024" QID="1" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F3BE000" SIZE="16" QID="0" IR_ENABLED="0" TYPE="ACQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E651000" SIZE="1024" QID="8" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E6B5000" SIZE="1024" QID="9" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F3ED000" SIZE="1024" QID="1" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E77D000" SIZE="1024" QID="11" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E7E1000" SIZE="1024" QID="12" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F153000" SIZE="1024" QID="4" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E719000" SIZE="1024" QID="10" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F08B000" SIZE="1024" QID="2" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F1B7000" SIZE="1024" QID="5" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23EFDB000" SIZE="1024" QID="7" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F1DA000" SIZE="1024" QID="6" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F0EF000" SIZE="1024" QID="3" IR_ENABLED="0" TYPE="IOCQ"/></Queues><Namespaces/><Interrupts/></DEVICE></DEVICES>

5.17 NVME Command Mode

Note: NVME Command Mode is available only for the following Summit T3 modes:

- T34
- T34 (2 units)

NVME Command mode is a Recording Option and is similar to NVMe Enhanced mode. However, NVME Command Mode allows you to filter in specific NVMe commands and registers. It also supports some PCIe filtration, such as DLLPs and interrupts. NVME Command Mode supports commands according to NVMe 2.0 specification.

NVME Command Mode has options for Simple Mode and Advanced Mode.

5.17.1 NVME Command Mode - Simple verses Advanced Mode

When you select Simple mode while in NVME Command Mode then commands, warnings, and the **Set Namespace ID** button display in the General tab in Recording Options. See Figure 5.153.

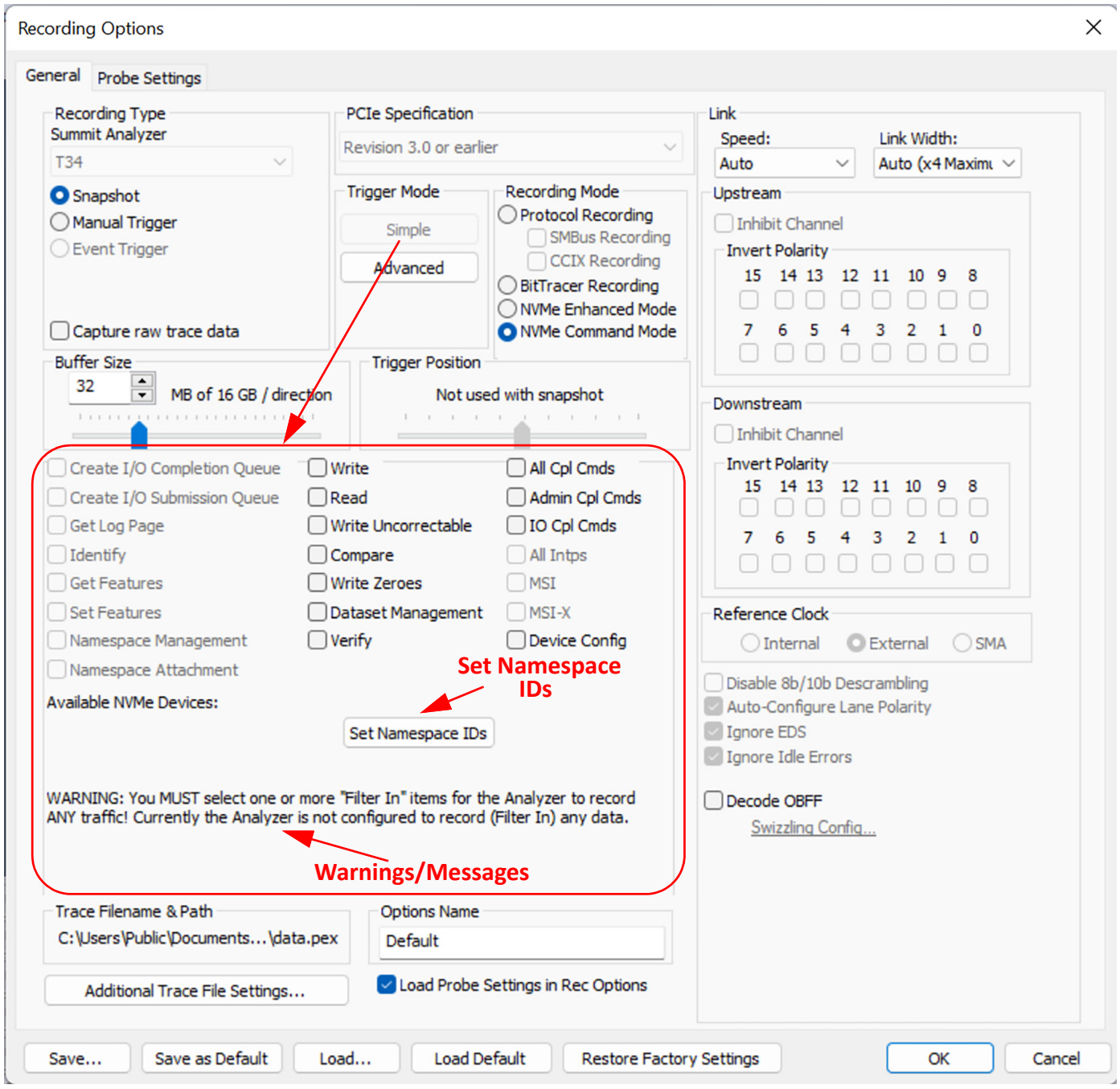


Figure 5.153: NVME Command Mode: Simple Mode

When selecting Advanced Mode in NVME Command Mode, the Recording Rules tab appears. Commands, warnings, and the **Set Namespace IDs** button are on the Recording Rules tab. See Figure 5.154 and Figure 5.155.

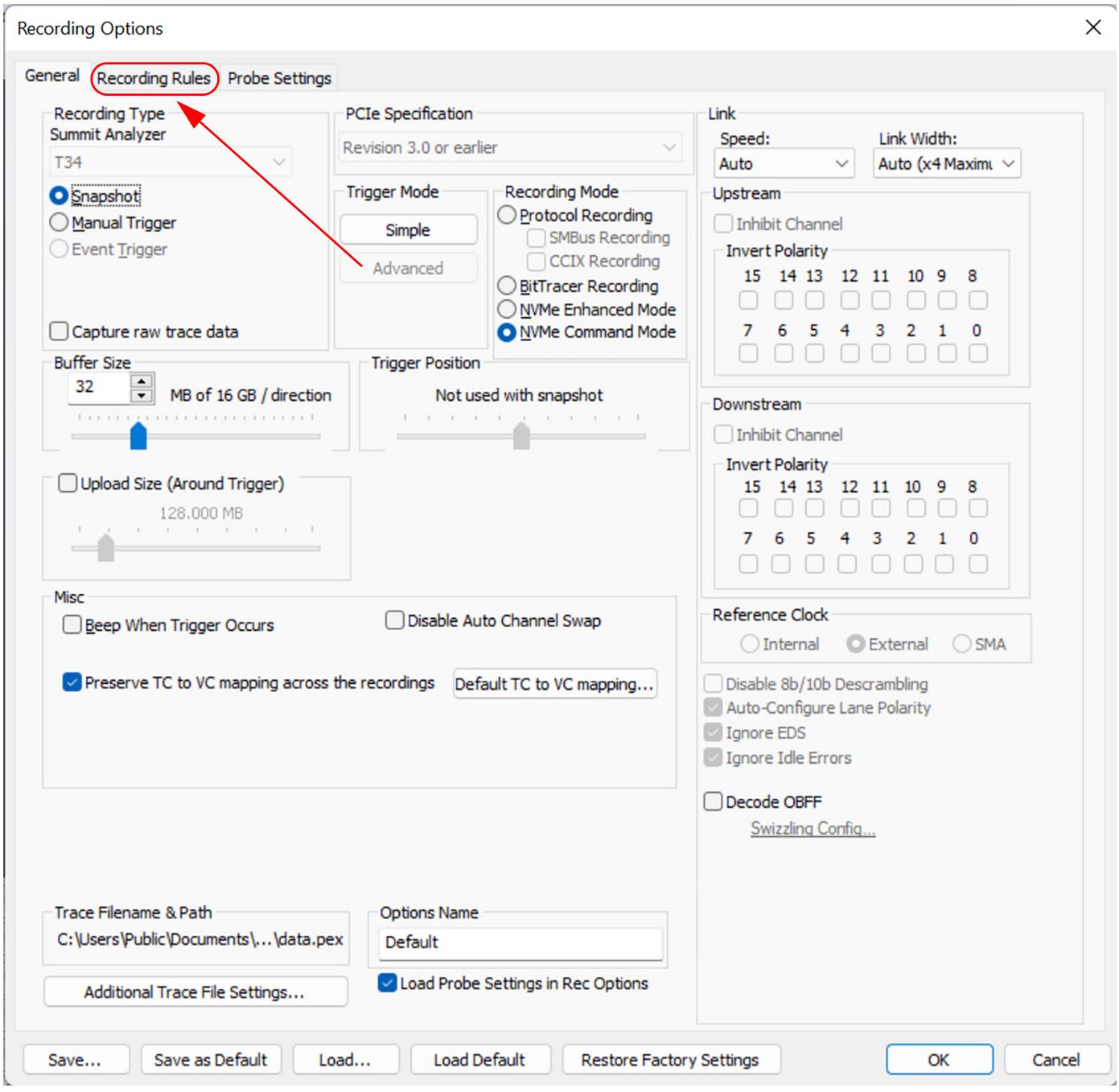


Figure 5.154: NVME Command Mode: Advanced Mode

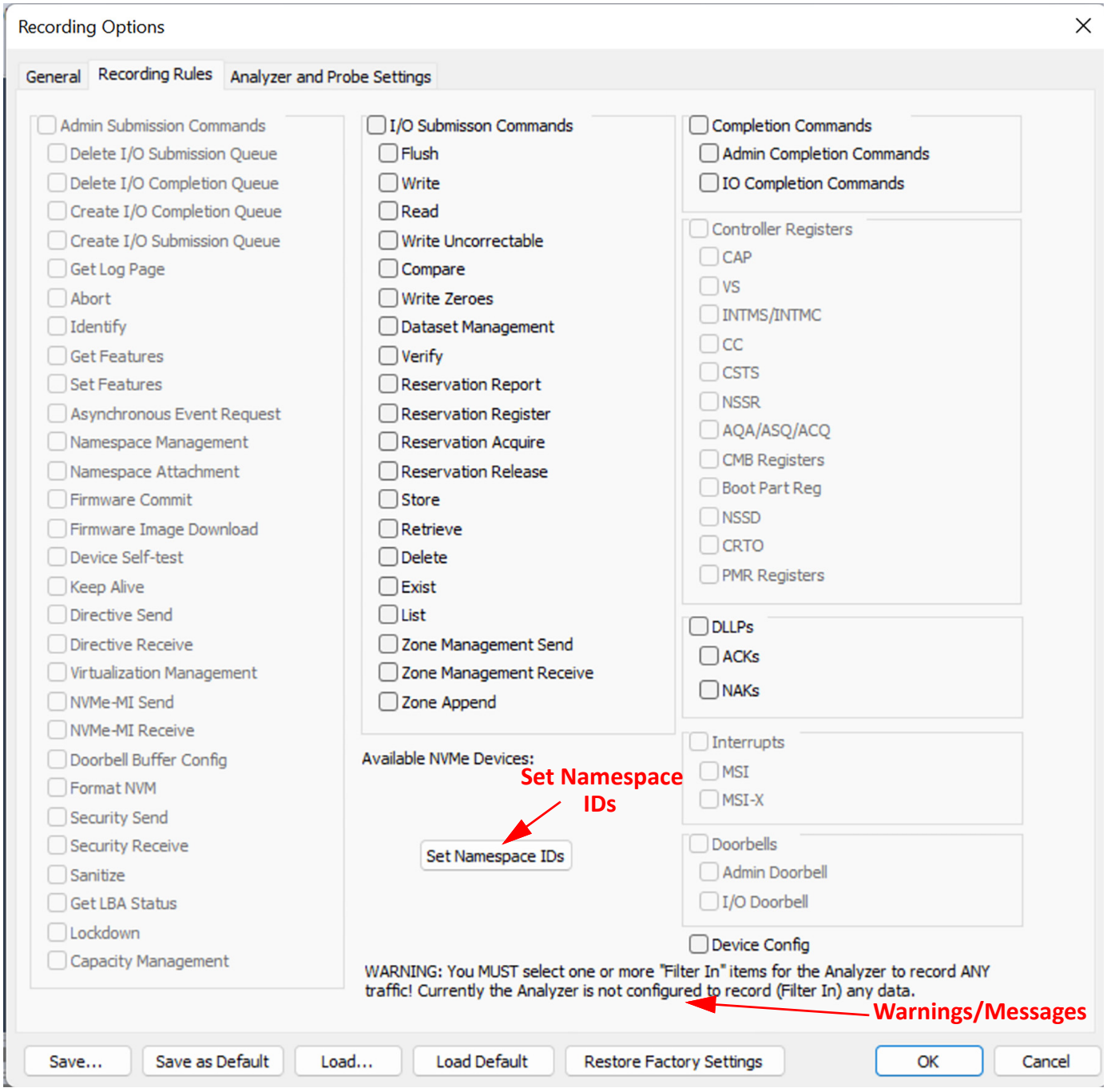


Figure 5.155: NMVE Command Mode: Advanced Mode Recording Rules

5.17.2 Set Namespace IDs

With NVME Command Mode, you can set namespace identifications using the **Set Namespace IDs** button. See Figure 5.156.

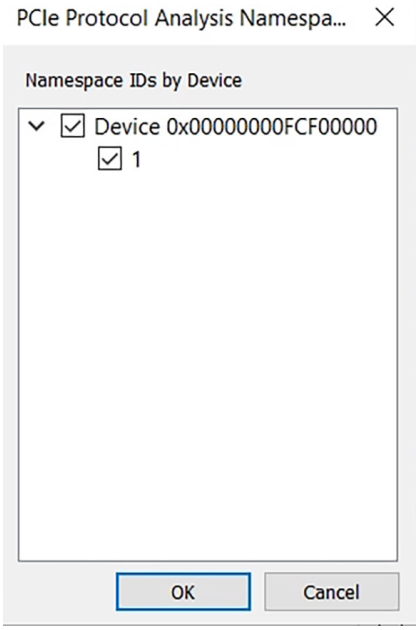


Figure 5.156: NVME Command Mode: Set Namespace IDs

5.17.3 NVME Command Mode Warnings

Warnings exist within NVME Command Mode to help you create the best recordings for your devices.

When you first click on NVME Command Mode and do not have a valid SSD Device Configuration, a warning dialog displays. See Figure 5.157.

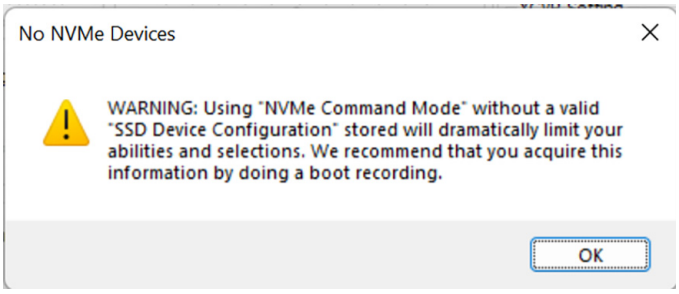


Figure 5.157: Warning: No valid SSD Device Configuration

If you do not select any NVME Command Space filters, then the following message displays:

> **Warning: You MUST select one or more “Filter In” items for the Analyzer to record ANY traffic! Currently the Analyzer is not configured to record (Filter In) any data.**

If you select too many filters, then the following message displays:

> **Not enough bus engine resources to fit this item. Precision can decrease.**

Chapter 6

Reading CATC Traces

6.1 Viewing PCI Express CATC Traces

PCIe Protocol Analysis™ displays traffic as labeled, color-coded, and time-stamped rows.

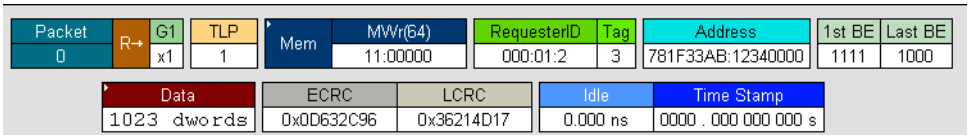


Figure 6.1: Typical CATC Trace

Tool tips provide details about fields within the CATC Trace. Hold the mouse cursor over a field to see a tool tip.

Additional information is available from pop-up menus. For example, if you click the left mouse button on the first cell in a packet a menu appears with an option to view Raw 10b Codes.

6.2 Expand and Collapse Data Fields

Packet data fields are displayed in a short format by default.

You can view a data field's long format by performing one of the following three actions:

- Click the **small triangle** in the left corner.
- Double-click anywhere in the data field.
- Click once in the Data Field with the left mouse button, then choose **Expand Data** from the pop-up menu.

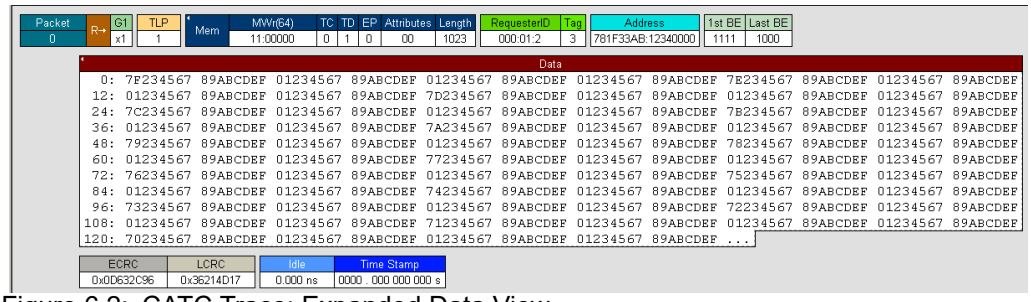


Figure 6.2: CATC Trace: Expanded Data View

A repeat of any above methods causes the display to return to a Short Data format.

6.3 Resizing Cells

Data cells can be resized by pointing the mouse pointer on the edge of a data cell, depressing and holding the left mouse button, and then repositioning the mouse pointer while keeping the mouse button depressed.

6.4 Pop-up Menus

The Analyzer software makes extensive use of pop-up menus. In some instances, pop-up menus provide the only means of accessing dialogs that contain detailed information about cells within the CATC Trace, for example, the Show Configuration Space dialog.

To see a pop-up menu, left-click or right-click a **cell** within the CATC Trace. Right-click or left-click behavior depends on the Display Options setting. For default left-click, the right-click menu is not cell-dependent. For other left-click behavior, the type of menu that opens varies depending on the type of cell that is selected. Take some time to explore CATC Traces and the various pop-up menus.

6.5 View Data Block

To view the raw bits that make up the data in a data field, left-click a data field, then click  or select **View Data Block** from the pop-up menu to display the Data Block window

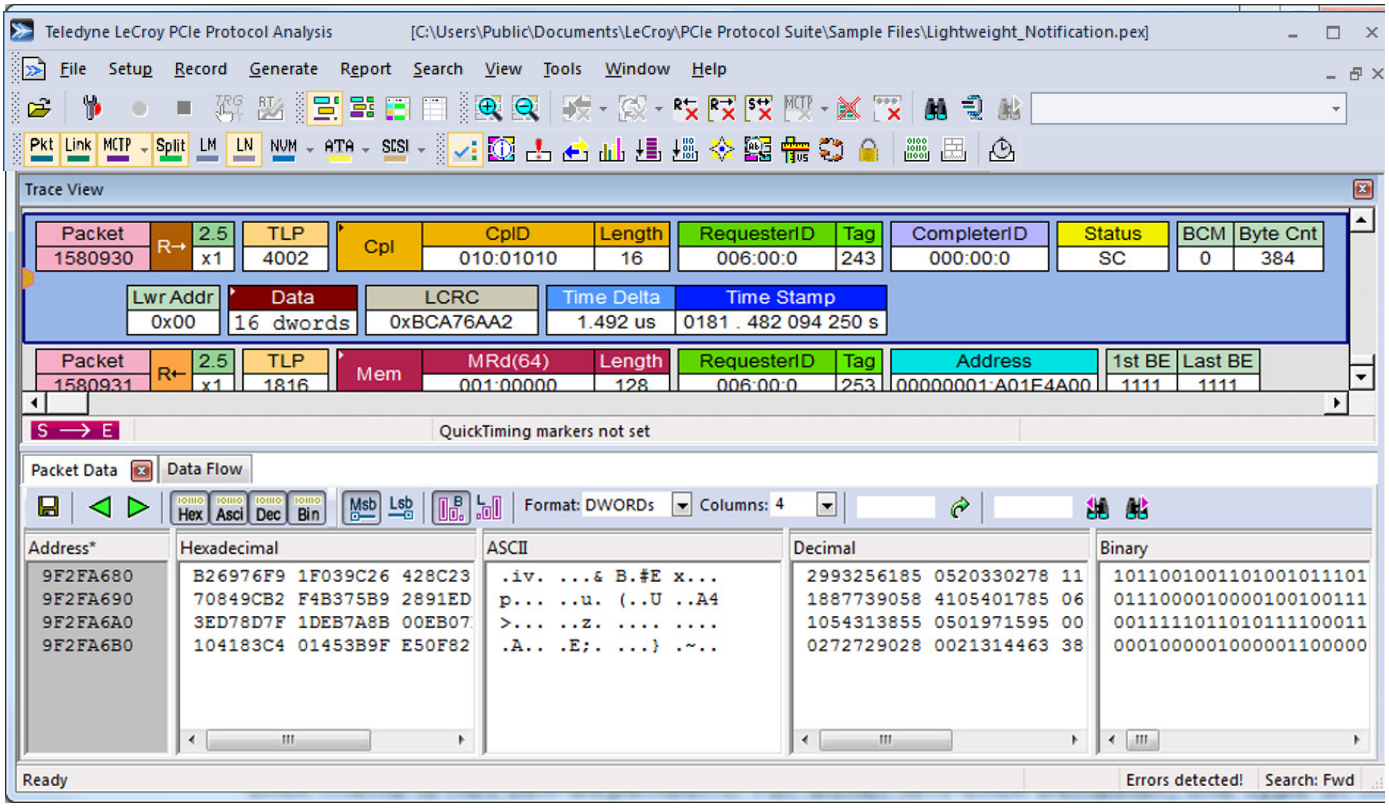


Figure 6.3: Viewing a Data Block

You can display data in Hexadecimal, ASCII, Decimal, or Binary formats.

Bit Order is Most Significant Bit or Least Significant Bit.

You can display data in Big Endian or Little Endian.

Format lets you display data as BYTEs, WORDs, or DWORDs.

Columns lets you select the number of columns.

You can enter hexadecimal offset values.

You can go to or search Previous or Next.

6.5.1 Save Data Block

You can also **Save** the data in Hexadecimal, ASCII, Decimal, or Binary formats. See Figure 6.4.

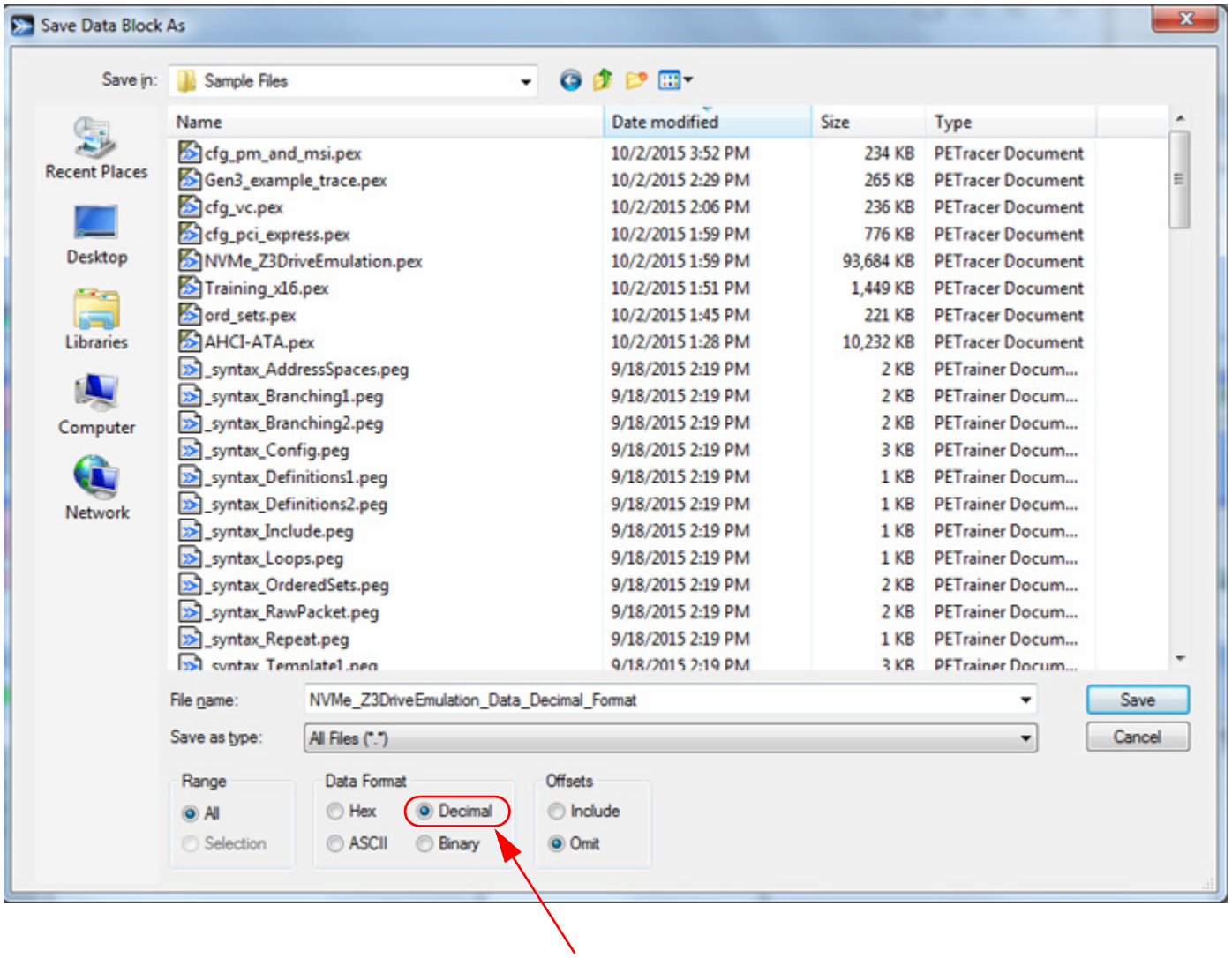


Figure 6.4: Save Data Block In Hex, Decimal, ASCII or Binary

The Saved file is shown in Figure 6.5 on page 386.

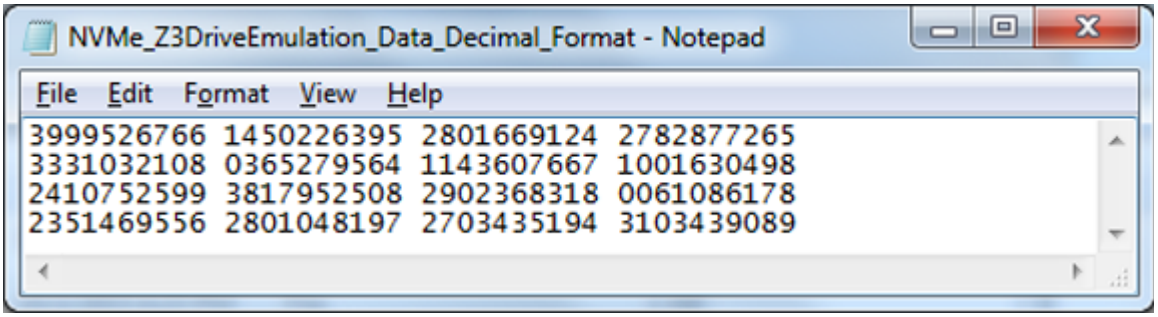


Figure 6.5: Saved Data File in Decimal Format

6.6 Show Raw 10b Codes

You can view the raw bits that make up the data field by right-clicking the field and selecting **View Data Block** from the pop-up menu.

To view Raw 10b Codes:

1. Right-click the **first cell** in a packet.
2. Select **Show Raw 10b Codes** from the pop-up menu to display the Raw 10b Codes window.

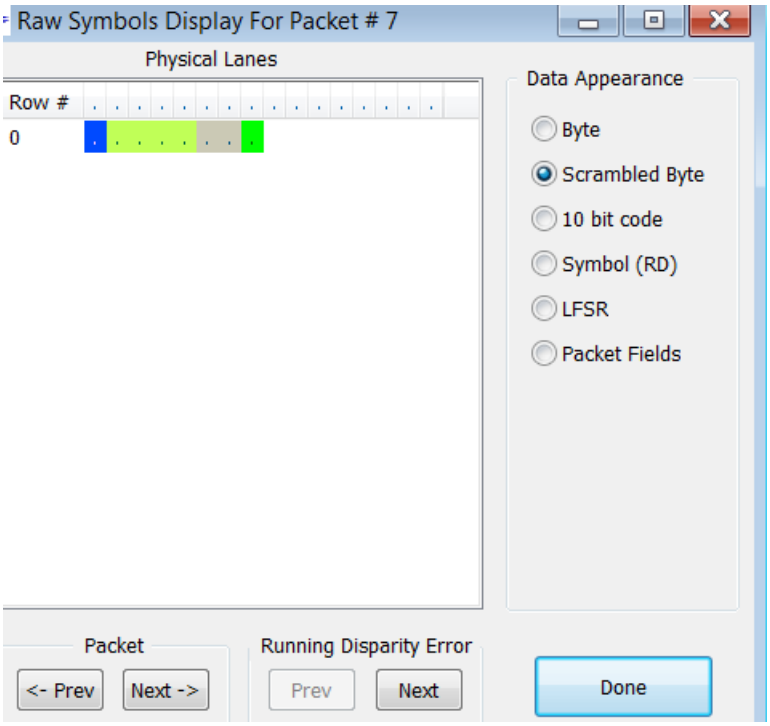


Figure 6.6: Show Raw 10b Codes Dialog

3. To change the format of the data, use the options along the right side of the dialog.
4. To navigate the CATC Trace, use the **Prev** and **Next** buttons.

6.7 Show Header Fields

You can view details about header fields by opening the Show Header Fields dialog.

1. Click a **header.** A pop-up menu displays (see the following figure).

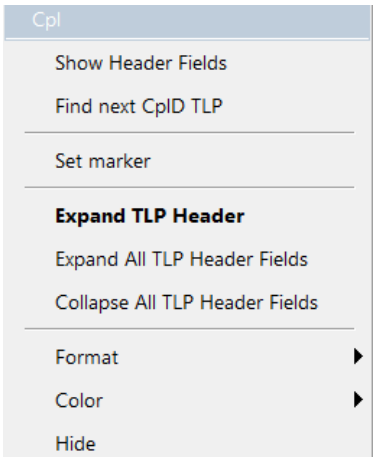


Figure 6.7: CATC Trace View: Header Popup Menu

2. Select **Show Header Fields**. The following dialog opens.

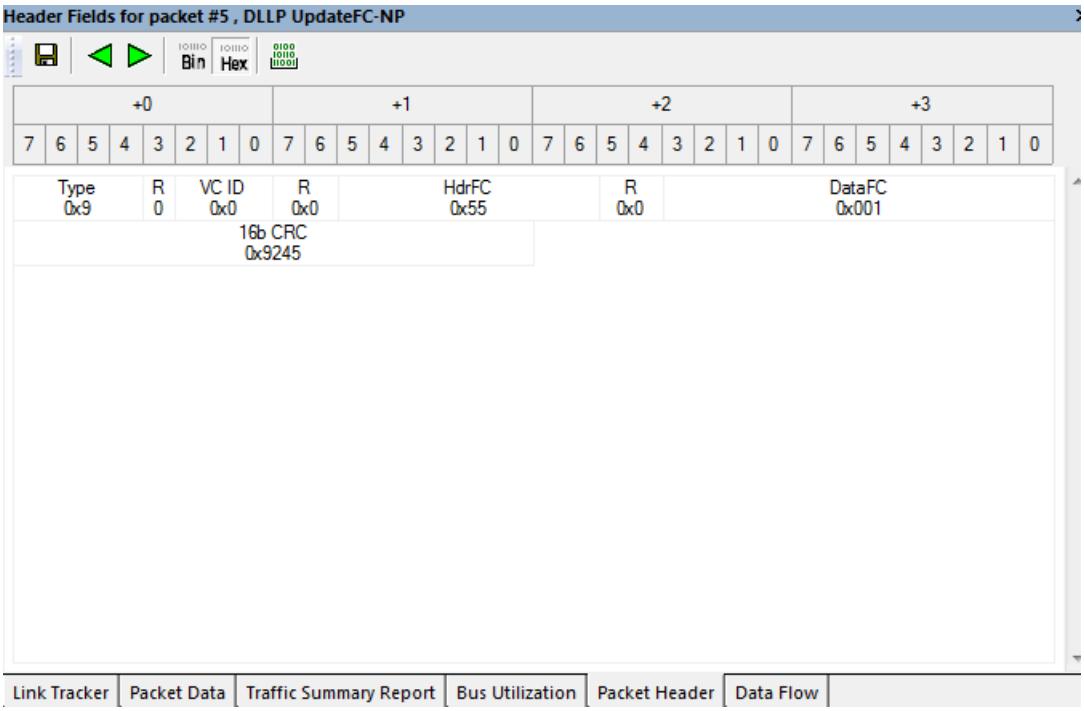


Figure 6.8: Viewing Packet Fields

3. Use the **Prev** and **Next** buttons to navigate to other headers.

6.8 Packet Cell Popup Menus

The Packet cell has a right-click pop-up menu that includes the following topics. See Figure 6.9.

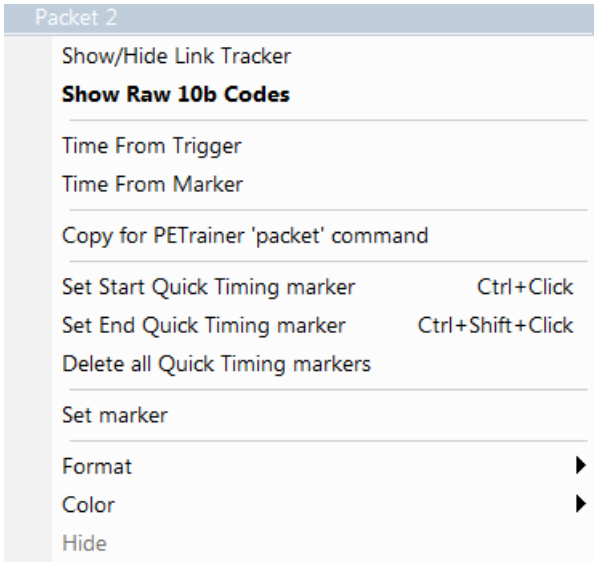


Figure 6.9: Packet Cell Popup Menu

Each topic can be selected and generate more information about the topic. The following sections describe each of the topics in the menu.

6.8.1 Show/Hide Link Tracker

Click on the “Show/Hide Link Tracker” and the Link Tracker View will show up in the Main Display window. See Figure 6.10.

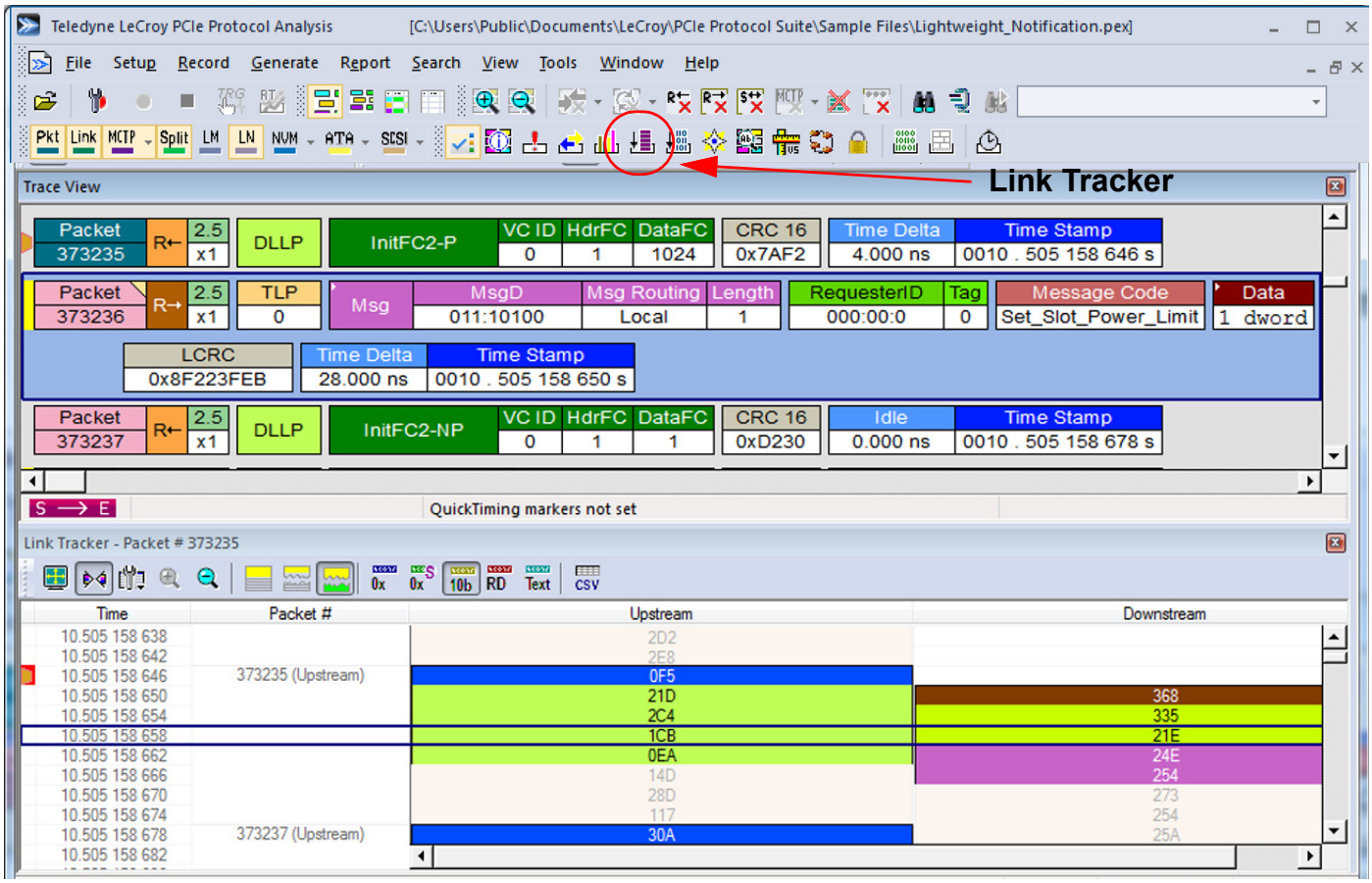


Figure 6.10: Packet Cell Popup Menus: Trace View and Link Tracker View

Link Tracker is discussed in more detail in “Link Tracker” on page 648.

6.8.2 Show Raw 10b Codes

Click on Show Raw 10b Codes and the Raw Symbols Display for the selected Packet pops up. See Figure 6.11.

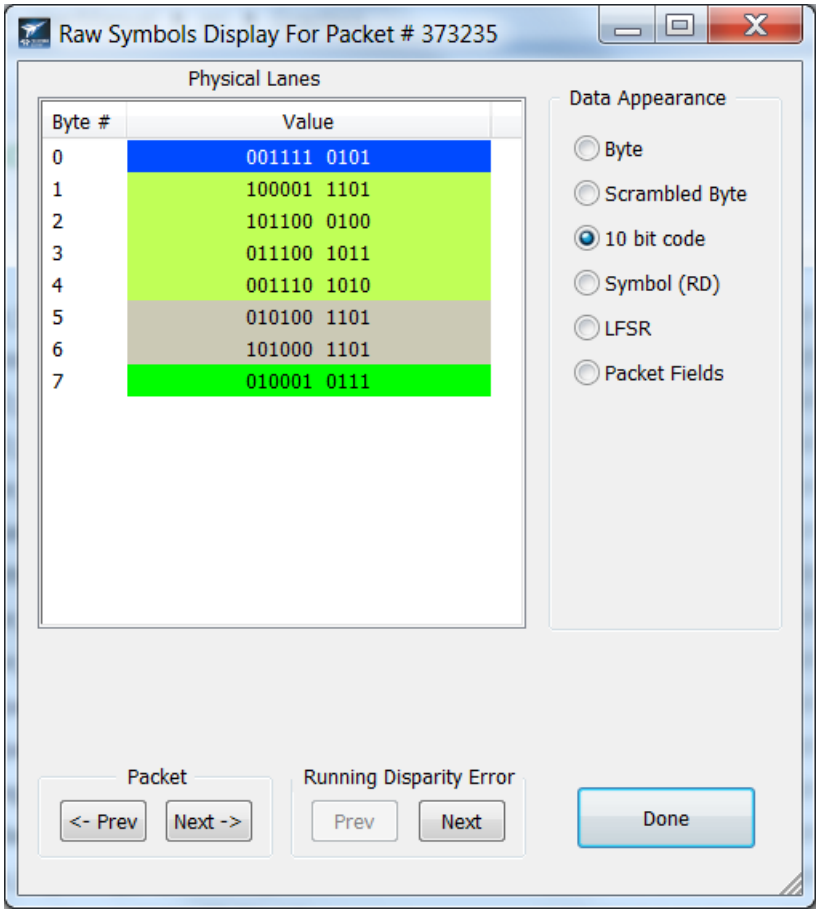


Figure 6.11: Packet Cell Popup Menus: Show Raw 10b Codes

Raw 10b Codes is discussed in more detail in "Show Raw 10b Codes" on page 386.

6.8.3 Time From Trigger

Select Time From Trigger and the Timing Calculator pops up. See Figure 6.12.

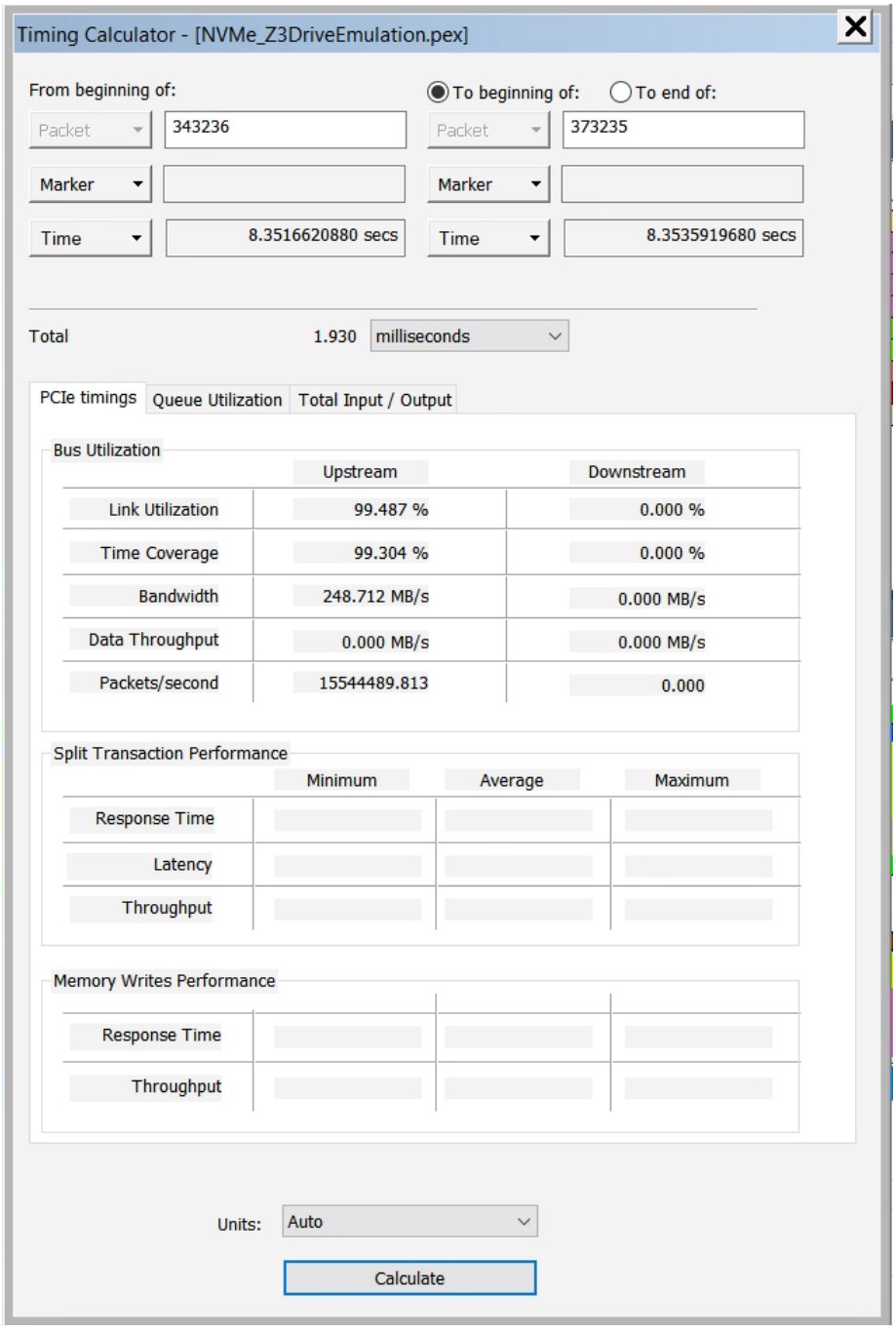


Figure 6.12: Packet Cell Popup Menus: Timing Calculator

The Timing Calculator is discussed in more detail in "Timing Calculator" on page 686.

6.8.4 Time From Marker

Click on Time From Marker and the following menu pops up along with the Timing Calculator. See Figure 6.13.

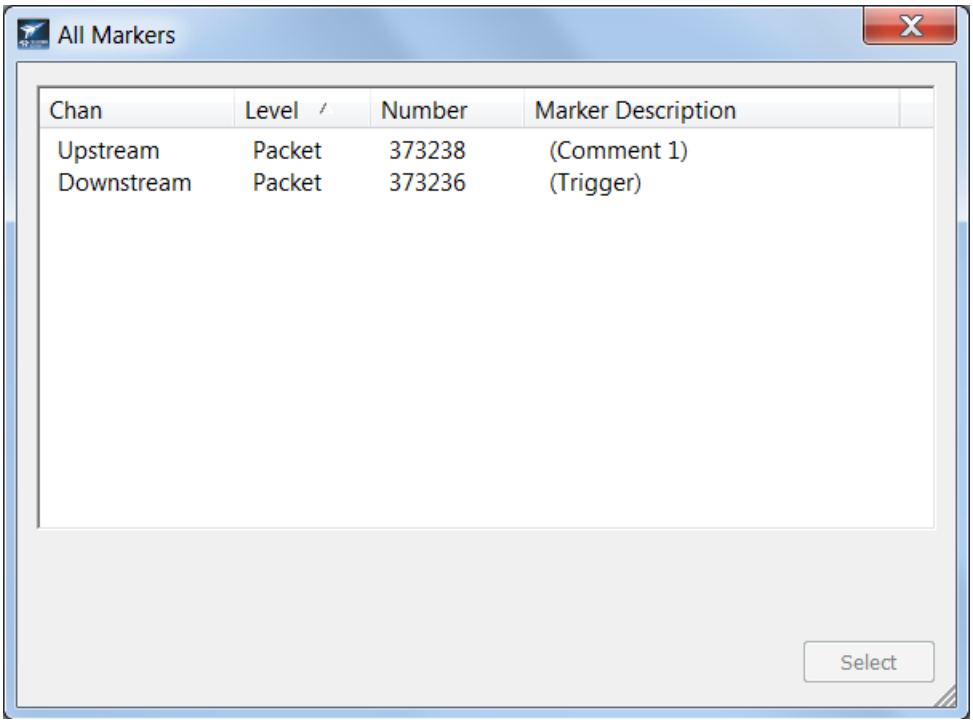


Figure 6.13: Packet Cell Popup Menus

Markers are discussed in more detail in "Set Marker" on page 394 and the Timing Calculator is discussed in more detail in "Timing Calculator" on page 686.

6.8.5 Copy for PETrainer 'packet' command

Select a packet, right click to bring up the Packet Cell Popup Menu, select the Copy for PETrainer 'packet' command and the tool will copy the Packet information which can then be copied into a PETrainer script for use with Teledyne LeCroy exercisers (Z3-16 etc.).

An example is shown below of a typical Packet and the PETrainer commands generated:

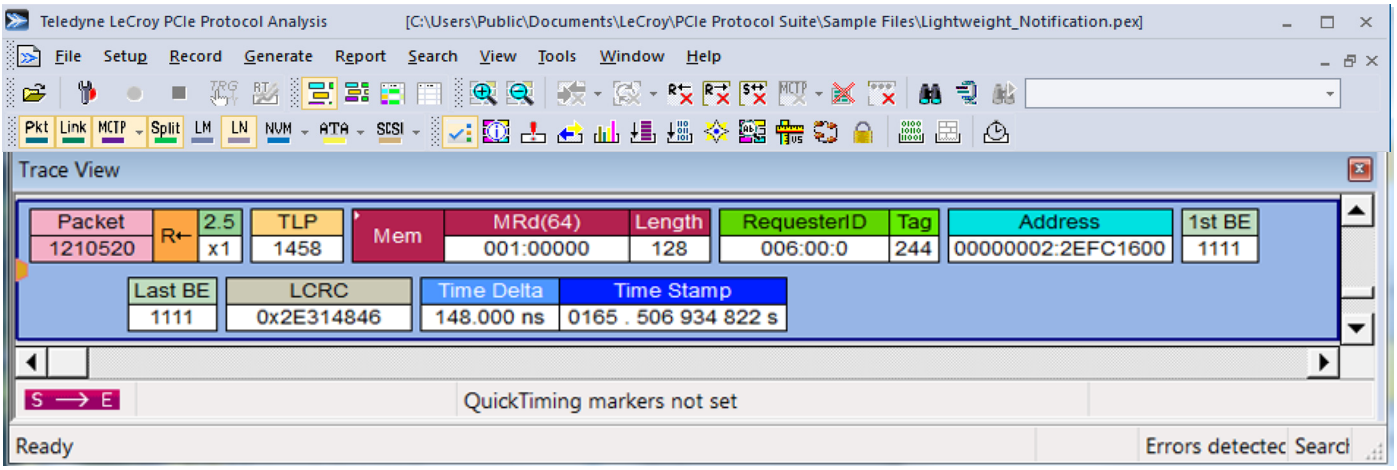


Figure 6.14: Packet Cell Popup Menus: Copy for PETrainer 'packet' Command

The script produced looks like this and can be copied into an existing trainer script:

```
packet = TLP {
    PSN = 0x5B2
    TLPType = MRd64
    TC = 0x0
    TD = 0x0
    TH = 0x0
    EP = 0x0
    IDBasedOrdering = 0x0
    Ordering = 0x0
    Snoop = 0x0
    AT = 0x0
    Length = 0x80
    RequesterId = (6:0:0)
    Tag = 0xF4
    LastDwBe = 0xF
    FirstDwBe = 0xF
    AddressHi = 0x2
    AddressLo = 0x2EFC1600
}
```

6.8.6 Set Start Quick Timing Marker

Sets the start packet for the Quick Timing marker. An S symbol is displayed at the packet.

Quick Timing provides immediate time deltas and bandwidth calculations. If the Start is placed on a packet that contains an Address and Endpoint, the bandwidth for that combination is displayed in the Status Bar below the trace data.

Quick Timing Markers are special ""Start"" and ""End"" markers used to mark the boundaries of the calculations. The results are shown in a special Quick Timing Bar at the bottom of the TraceView. The markers are set from a context sensitive menu.



Figure 6.15: Packet Cell Popup Menus: Set Start Quick Timer Marker

6.8.7 Set End Quick Timing Marker

Sets the end packet for the Quick Timing marker. An E symbol is displayed at the packet.

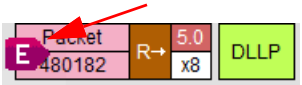


Figure 6.16: Packet Cell Popup Menus: Set End Quick Timer Marker

6.8.7.1 Quick Timing Bar

The Quick Timing Bar (see Figure 6.17 on page 394) at the bottom of the Trace View display window shows the following data between Markers:

- Delta Time
- Bus Utilization (both from Device to Host and from Host to Device)
- Data Throughput (both from Device to Host and from Host to Device)

Right click in the Quick Timing Bar to pop-up the menu to include or exclude the last selected packet/transaction from the timing, bus utilization and throughput calculations.

The data can be displayed in all available from selection units. Each value is described in bytes or bits value, to be comparable. Auto mode will select MB or GB automatically depending on result value so that values are more readable. The same units can be selected in Timing Calculator dialog.

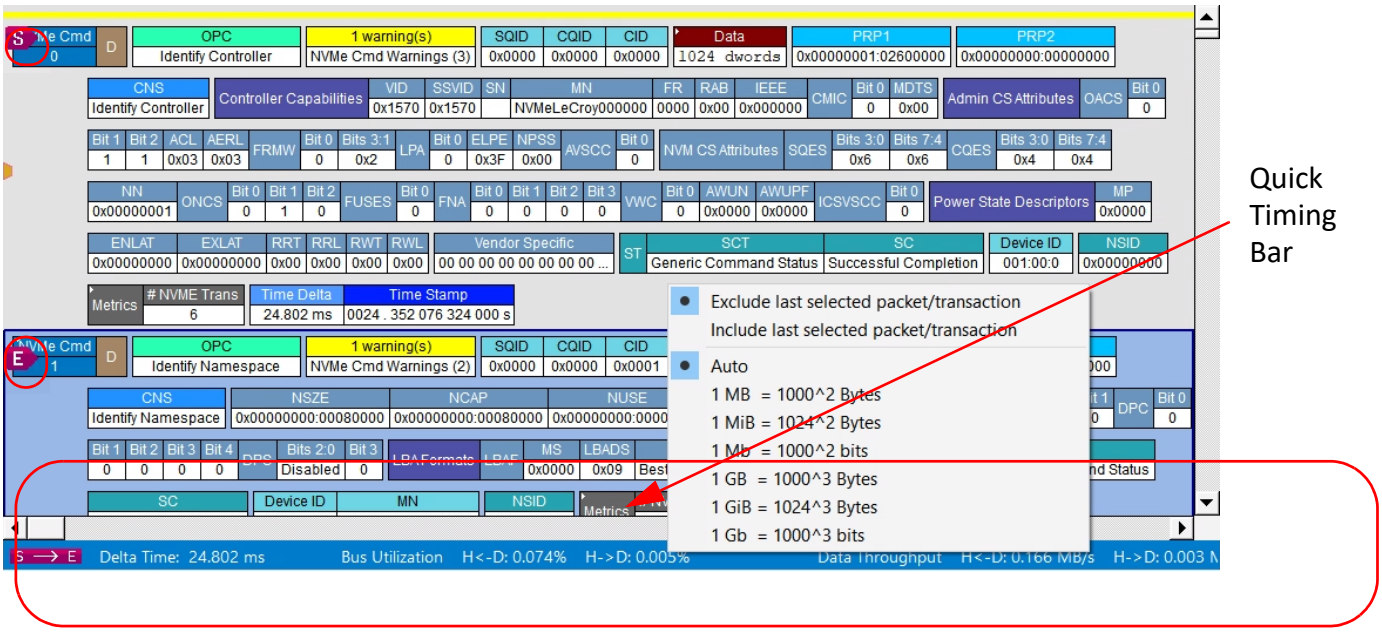


Figure 6.17: Quick Time Bar

6.8.8 Delete All Quick Timing Markers

Deletes all Quick Timing markers.

6.8.9 Set Marker

A marker is a unique label for a packet that allows you to go to that packet and also serves as a **comment string** for a specific packet. When you select a marker, the identified packet appears at the top of the screen. Packets that have been **marked** have a red bar on the left edge.

To set a marker, perform the following steps:

1. Right-click the **Packet** field of the packet you want to mark (see Figure 6.18 on page 395) or hover over the packet and click **Ctrl+K,** or select the packet and click **Ctrl+L**.

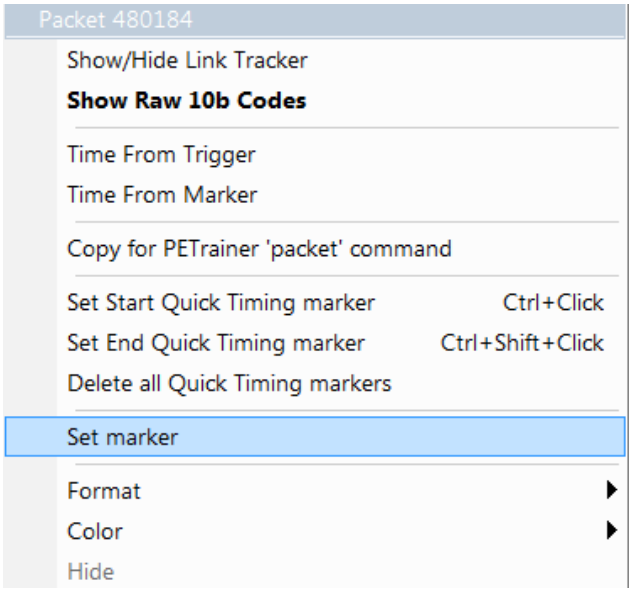


Figure 6.18: CATC Trace: Set Marker

2. Click **Set Marker**.
3. When the Create Marker for Packet # pop-up displays (see Figure 6.19), enter a unique identifier for the packet in the Comment field.

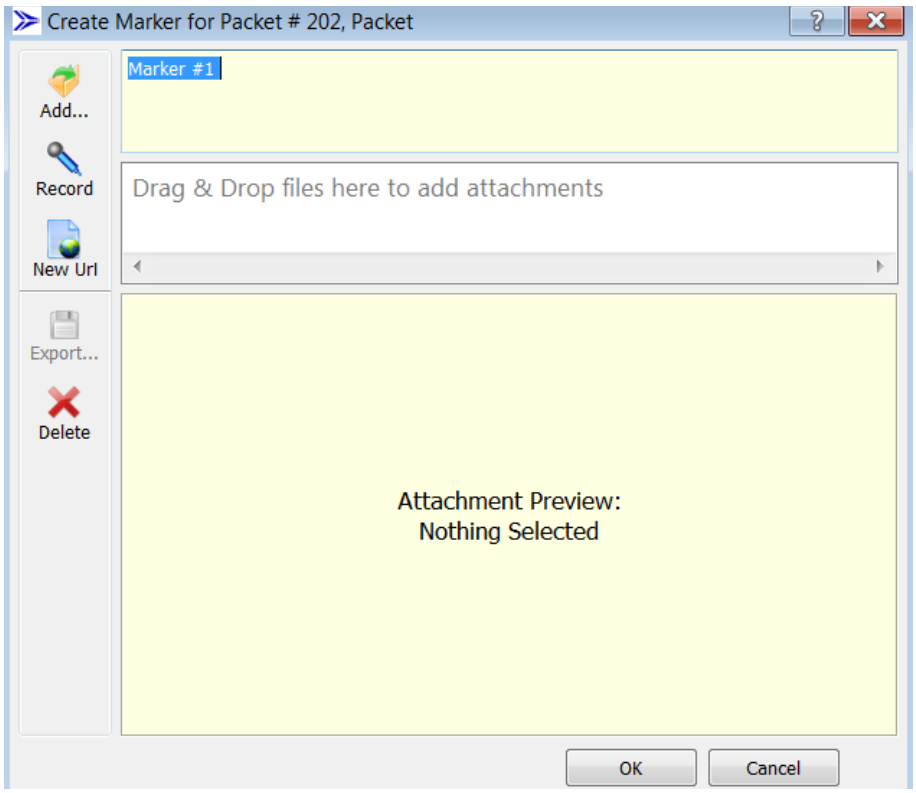


Figure 6.19: Create Marker for Packet Dialog

Later, you can go directly to this packet using the Go To Marker operation in the Search Menu.

6.8.10 Edit or Clear Marker

To change a markers identifier, or clear (delete) the marker:

1. Right-click the **Packet** field of the desired packet to display a pop-up menu (see Figure 6.20).

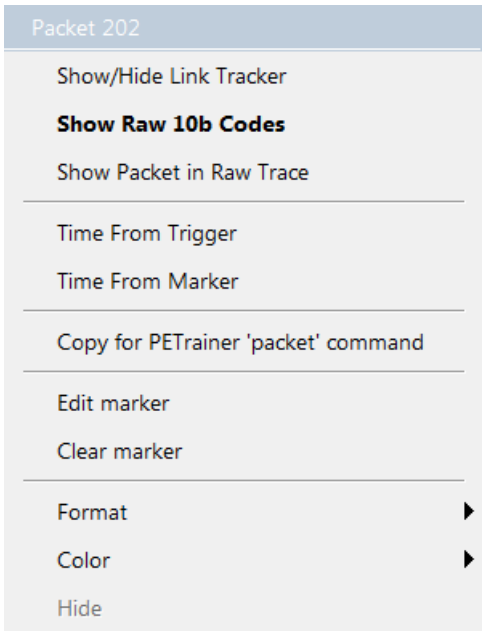


Figure 6.20: Edit Marker Pop-up Menu

2. Choose **Edit Marker** and enter a new identifier into the Edit Marker for Packer # pop-up, or
   choose **Clear Marker**. When you choose Clear Marker, the marker is removed and the red line disappears.

6.8.11 Format

Selecting Format from the Packet Cell Popup Menus will allow you to change the format of the data from Hex, Decimal, Binary or ASCII. See Figure 6.21.

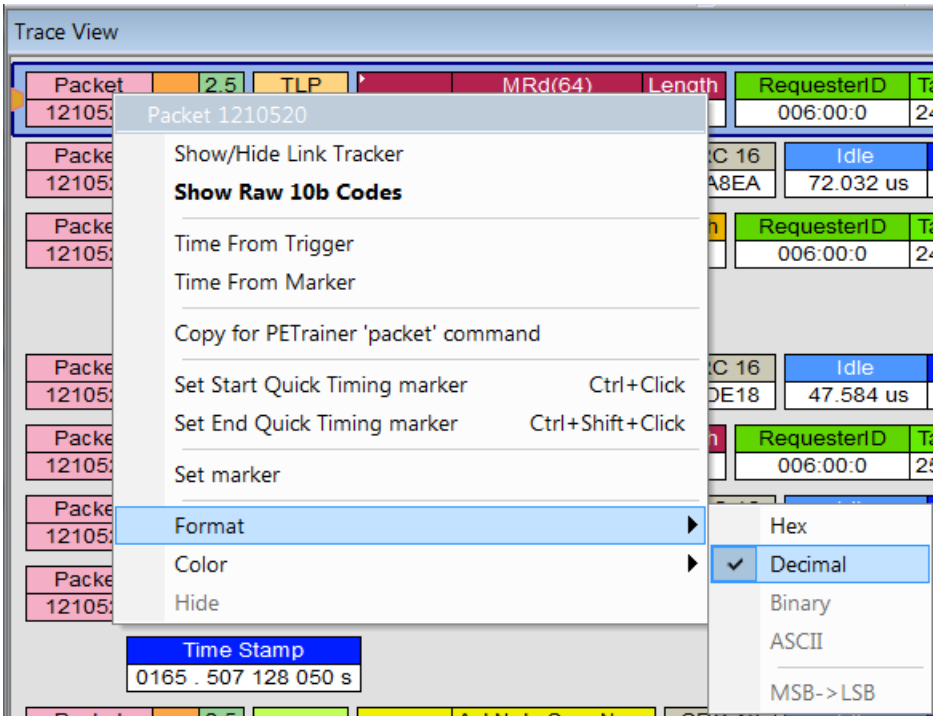


Figure 6.21: Packet Cell Popup Menus: Format

6.8.12 Color

Selecting the Packet Cell Popup Menu Color allows you to change the color of the Packet Cell. See Figure 6.22. Choose one of the twenty standard colors or pick Other for more choices.

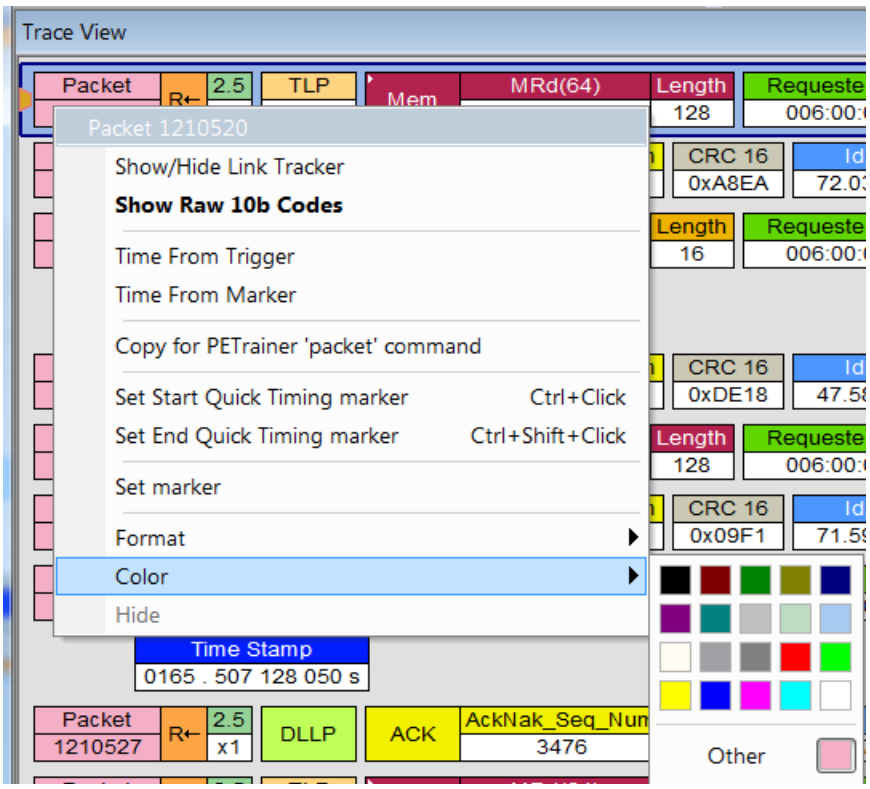


Figure 6.22: Packet Cell Popup Menus: Color

6.8.13 Other Packet Cell Popup Menus

6.8.13.1 Packet Header R-> Cell Popup Menu

The Packet Header R-> cell has a pop-up menu (see Figure 6.23) with the Swap Upstream/Downstream command, which changes the directionality of the packets in the CATC Trace.

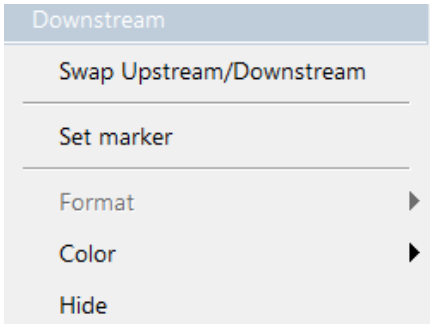


Figure 6.23: CATC Trace View: Packet Header Direction Popup Menu

6.8.13.2 Packet Header Speed Cell Popup Menu

The Packet Header Speed cell has a pop-up menu with the Show Header Fields command (see "Show Header Fields" on page 387), which exposes a detailed view of the selected Header field (see the following figure).

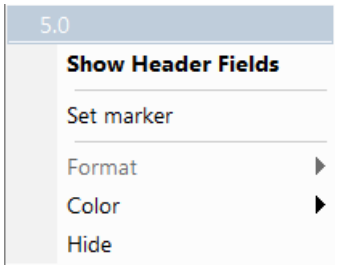


Figure 6.24: CATC Trace View: Packet Header Speed Popup Menu

6.9 Compressed CATC Trace View

The Compressed CATC Trace view shows fields in the format "Attribute: Value", whereas the normal CATC View shows the attribute name on top and the value below.

The Compressed CATC Trace view has almost all the information of the normal CATC View and behaves mostly the same way, while displaying more information on each window (see Figure 6.25 on page 399).

To compress the CATC Trace:

- Click  on the toolbar.

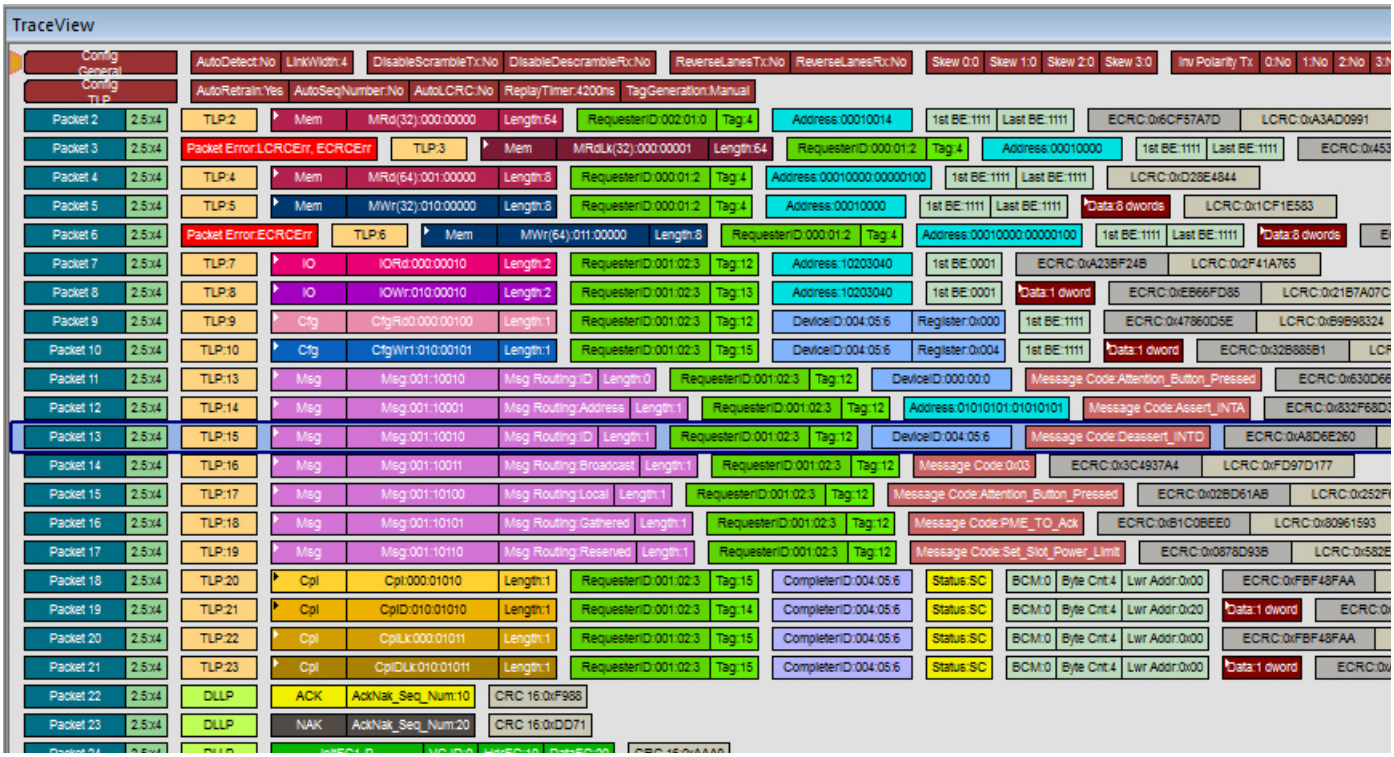


Figure 6.25: Compressed CATC Trace

- Click  on the toolbar to return to the normal CATC Trace View, or Select **View > Trace Views > CATC Trace.**

6.10 Spreadsheet View

You can view the CATC Trace as a spreadsheet in color or black and white.

Click  on the toolbar to display the Spreadsheet View (see Figure 6.26 and Figure 6.27).

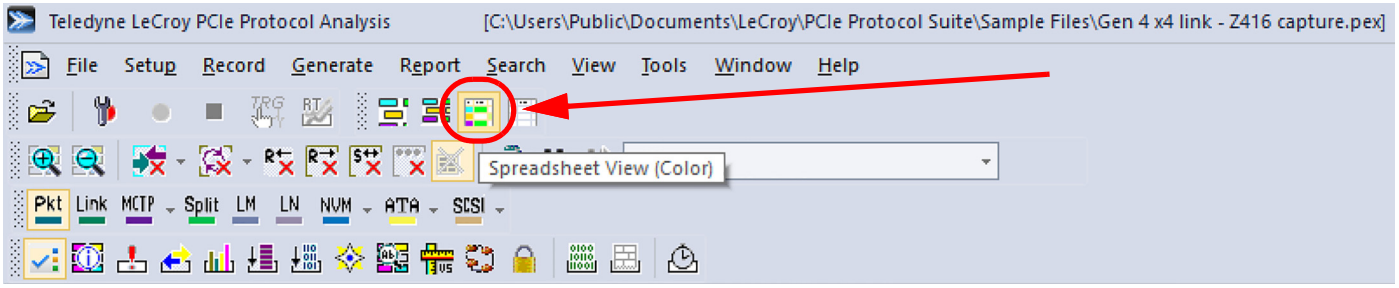


Figure 6.26: Spreadsheet View Icon in Toolbar

You can see the resulting Spreadsheet View of the trace below.

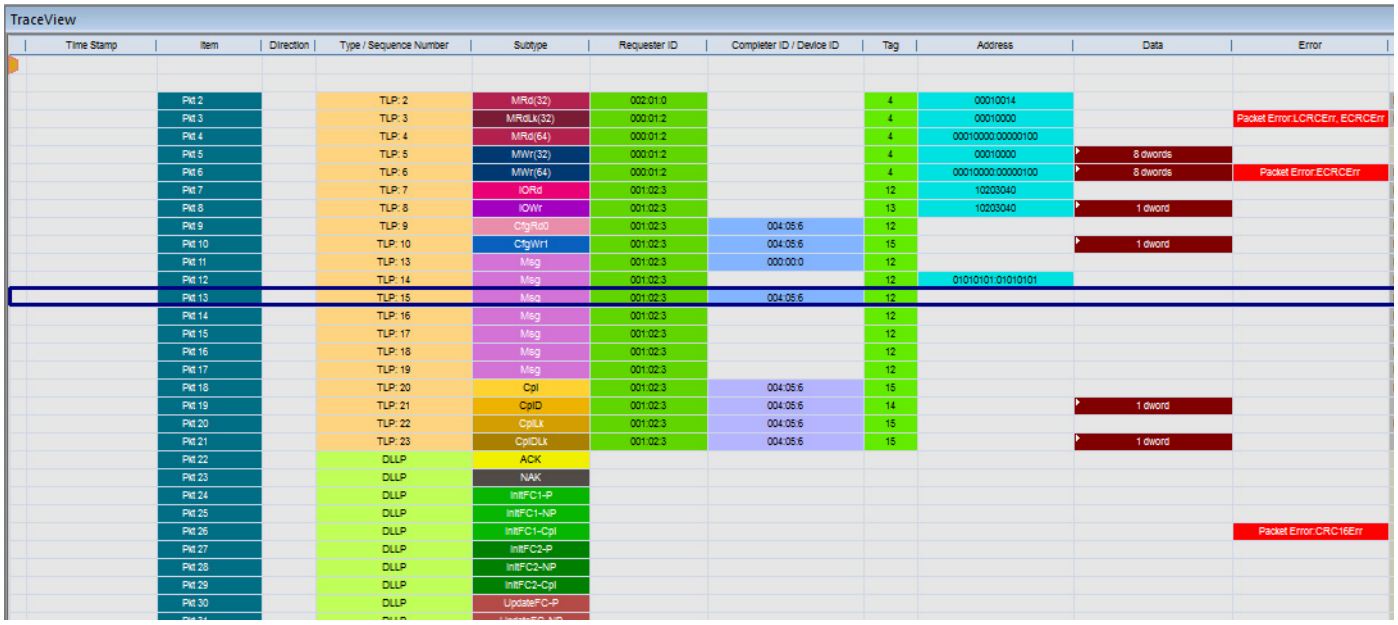
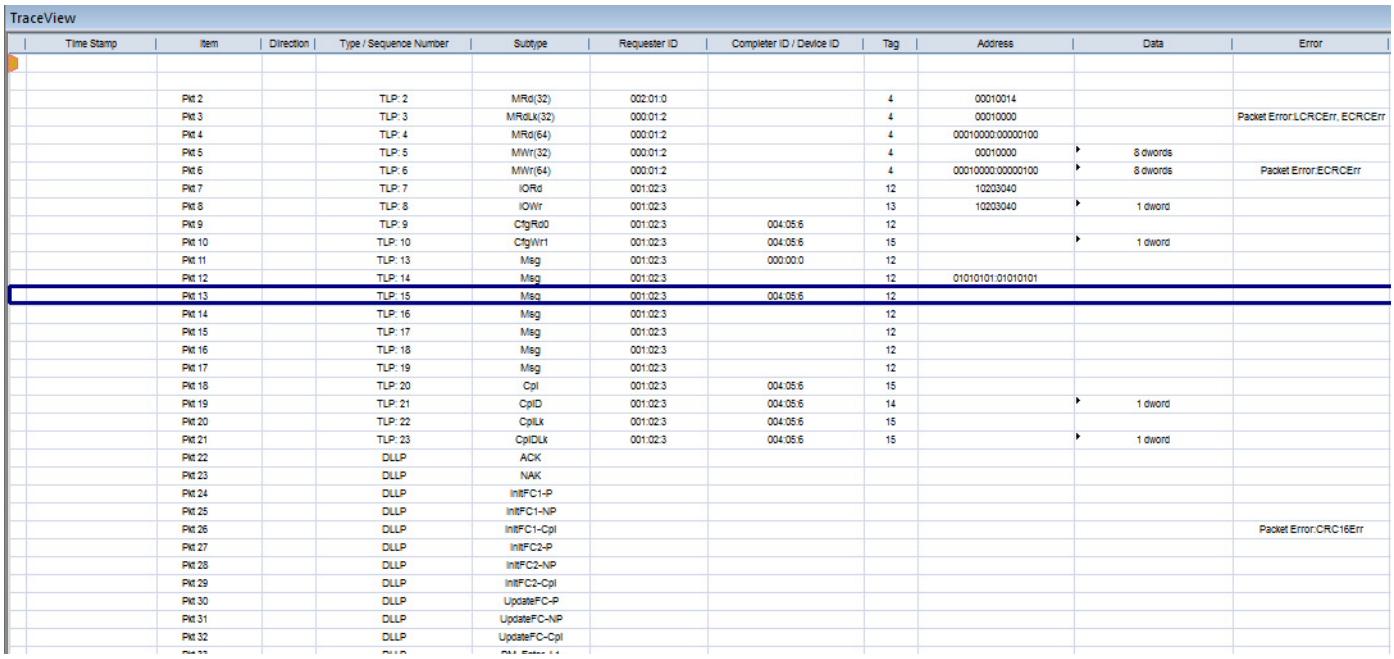


Figure 6.27: Spreadsheet View (Color)

- Click  on the toolbar to display the Spreadsheet View B/W.



TraceView

Time Stamp	Item	Direction	Type / Sequence Number	Subtype	Requester ID	Completer ID / Device ID	Tag	Address	Data	Error
	Pkt 2		TLP: 2	MRd(32)	002:01:0		4	00010014		
	Pkt 3		TLP: 3	MRdLk(32)	000:01:2		4	00010000		Packet Error:LCRCErr, ECRCErr
	Pkt 4		TLP: 4	MRd(64)	000:01:2		4	00010000:00000100		
	Pkt 5		TLP: 5	MWr(32)	000:01:2		4	00010000	8 dwords	
	Pkt 6		TLP: 6	MWr(64)	000:01:2		4	00010000:00000100	8 dwords	Packet Error:ECRCErr
	Pkt 7		TLP: 7	IORd	001:02:3		12	10203040		
	Pkt 8		TLP: 8	IOWr	001:02:3		13	10203040	1 dword	
	Pkt 9		TLP: 9	CfgRd0	001:02:3	004:05:6	12			
	Pkt 10		TLP: 10	CfgWr1	001:02:3	004:05:6	15		1 dword	
	Pkt 11		TLP: 13	Msg	001:02:3	000:00:0	12			
	Pkt 12		TLP: 14	Msg	001:02:3		12	01010101:01010101		
	Pkt 13		TLP: 15	Msg	001:02:3	004:05:6	12			
	Pkt 14		TLP: 16	Msg	001:02:3		12			
	Pkt 15		TLP: 17	Msg	001:02:3		12			
	Pkt 16		TLP: 18	Msg	001:02:3		12			
	Pkt 17		TLP: 19	Msg	001:02:3		12			
	Pkt 18		TLP: 20	Cpl	001:02:3	004:05:6	15			
	Pkt 19		TLP: 21	CplD	001:02:3	004:05:6	14		1 dword	
	Pkt 20		TLP: 22	CplLk	001:02:3	004:05:6	15			
	Pkt 21		TLP: 23	CplDLk	001:02:3	004:05:6	15		1 dword	
	Pkt 22		DLLP	ACK						
	Pkt 23		DLLP	NAK						
	Pkt 24		DLLP	InitFC1-P						
	Pkt 25		DLLP	InitFC1-NP						
	Pkt 26		DLLP	InitFC1-Cpl						Packet Error:CRC16Err
	Pkt 27		DLLP	InitFC2-P						
	Pkt 28		DLLP	InitFC2-NP						
	Pkt 29		DLLP	InitFC2-Cpl						
	Pkt 30		DLLP	UpdateFC-P						
	Pkt 31		DLLP	UpdateFC-NP						
	Pkt 32		DLLP	UpdateFC-Cpl						

Figure 6.28: Spreadsheet View (Black And White)

6.10.1 Columns

Right click on any column and the following options pop up. See Figure 6.29.

You can perform the following options:

- Add a Standard Column if one has been deleted
- Add a column with specific types of information for the current row selected
- Remove a column
- Restore the default columns

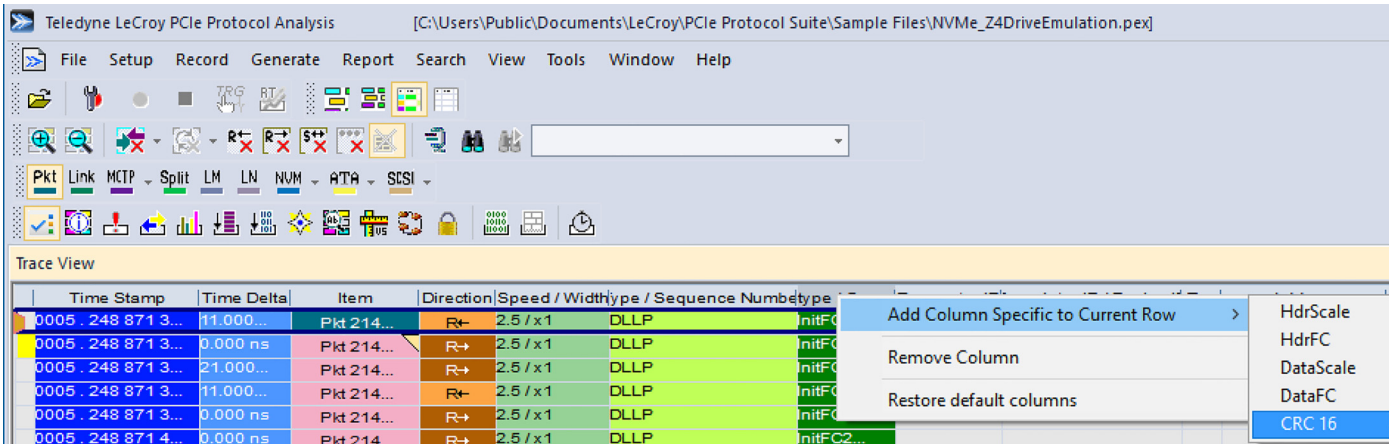


Figure 6.29: Add Columns Specific to Current Row

You can add a column with the CRC 16 values. See Figure 6.30

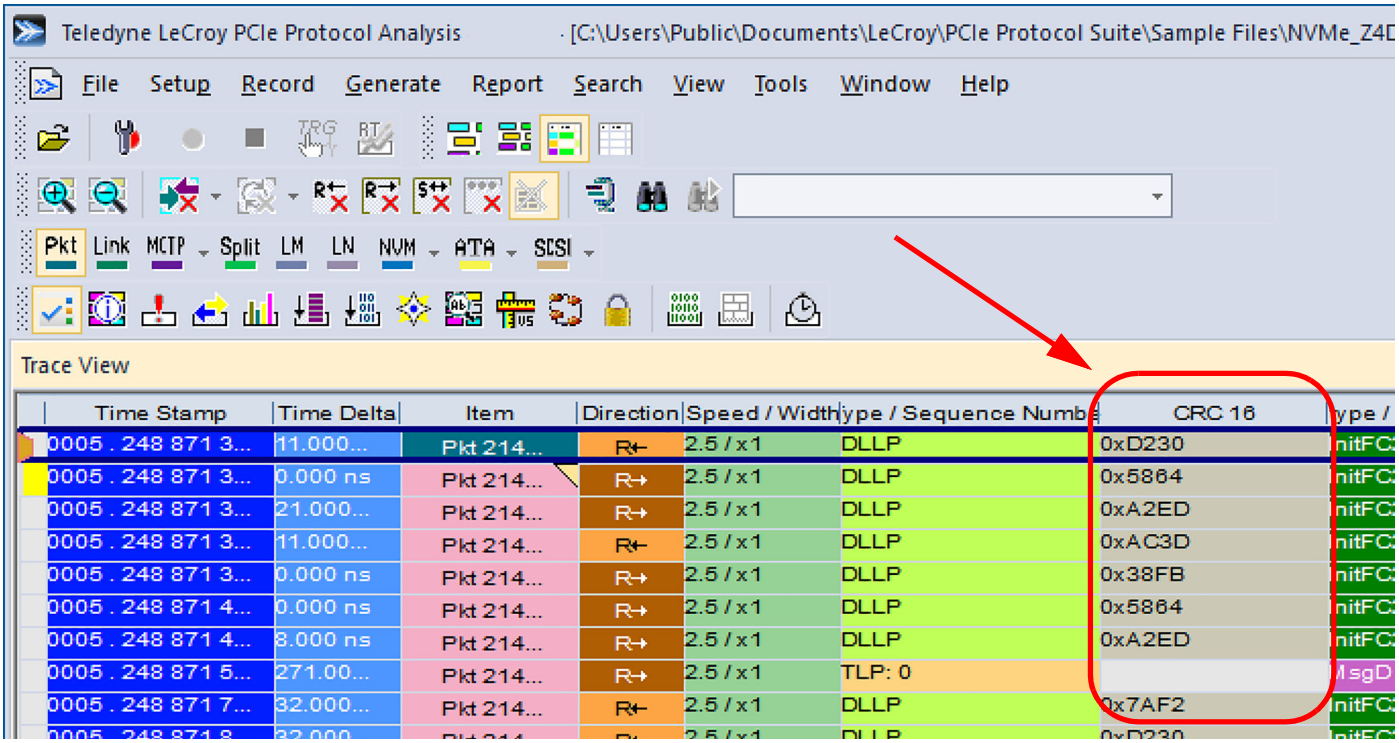


Figure 6.30: Added Column with CRC 16

You can delete the column that you right clicked on. See Figure 6.31.

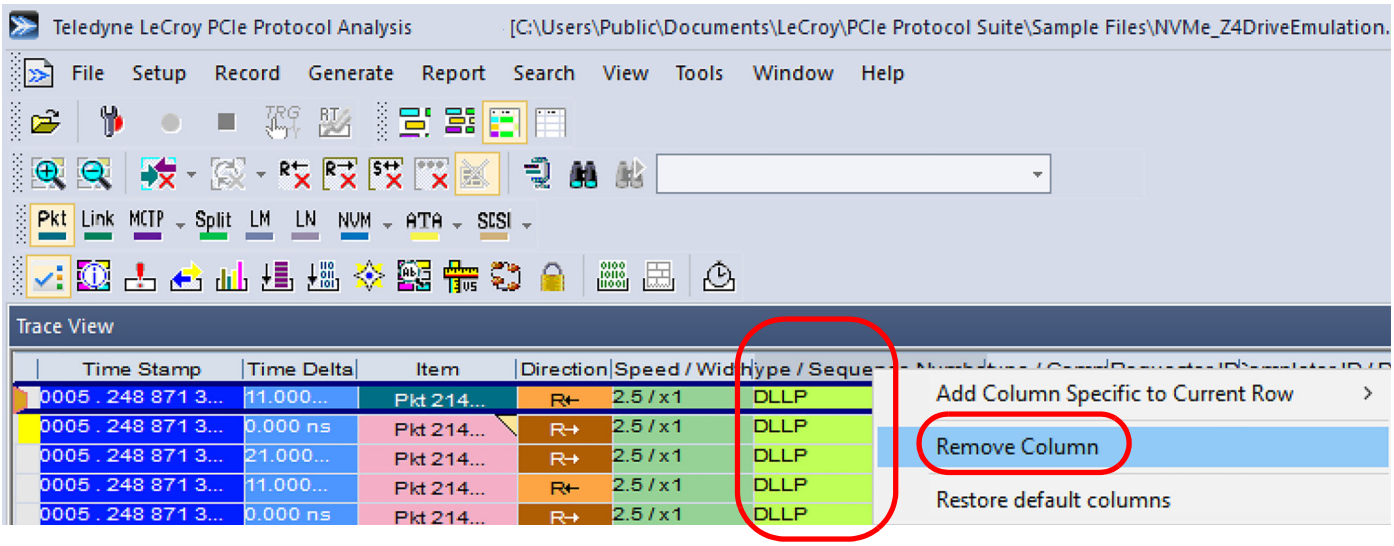


Figure 6.31: Right Click on Type/Sequence Number Column

Click on Remove Column and it's deleted from Spreadsheet View. See Figure 6.32.

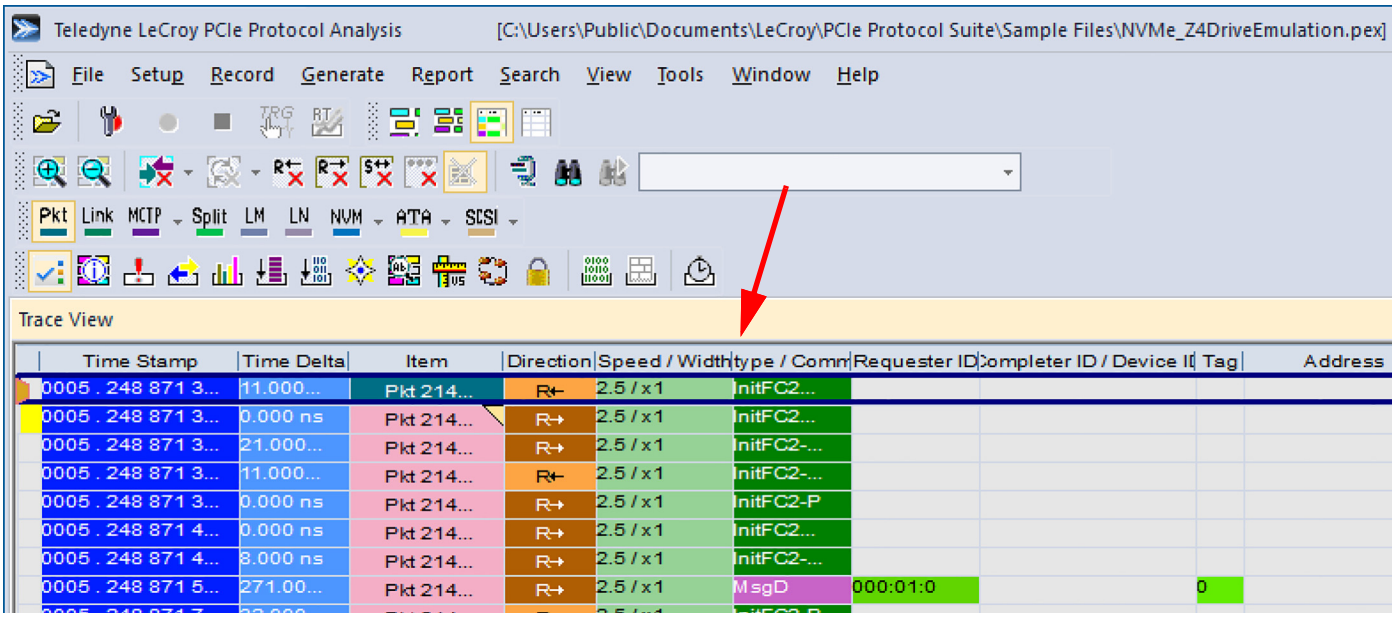


Figure 6.32: Selected Column Removed

You can also Restore the set of system Default columns. See Figure 6.33 on page 404.

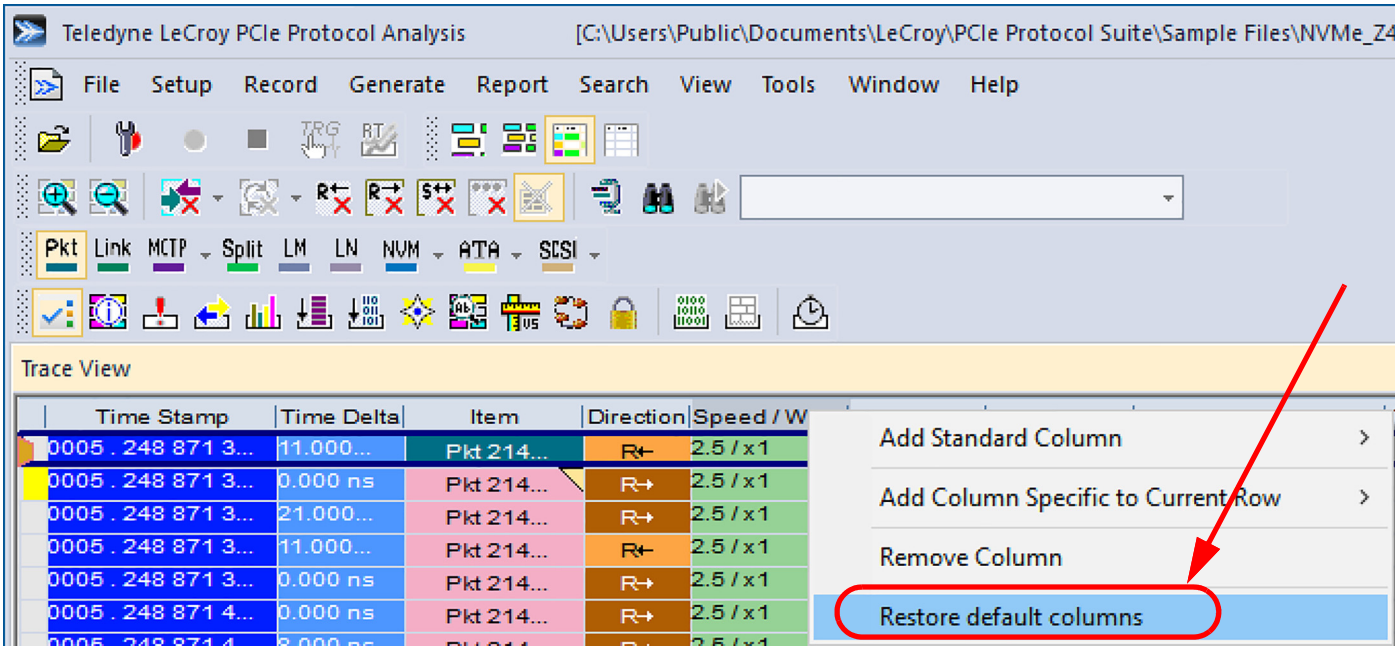


Figure 6.33: Restore Default Columns

If you select Restore default columns you'll get a Warning message. See Figure 6.34.

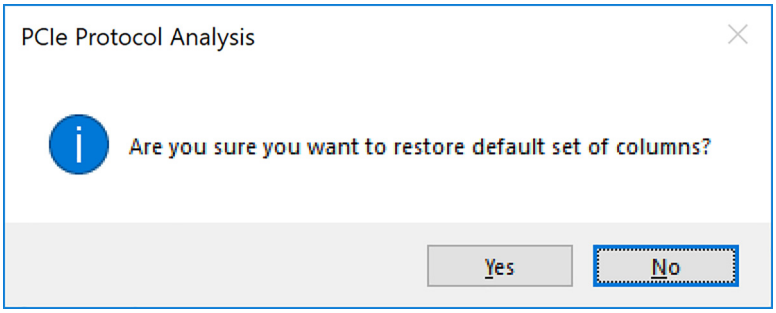


Figure 6.34: Warning Message about Restoring Default Set of Columns

Click on Yes and you'll get the default set of columns. See Figure 6.35 on page 405.

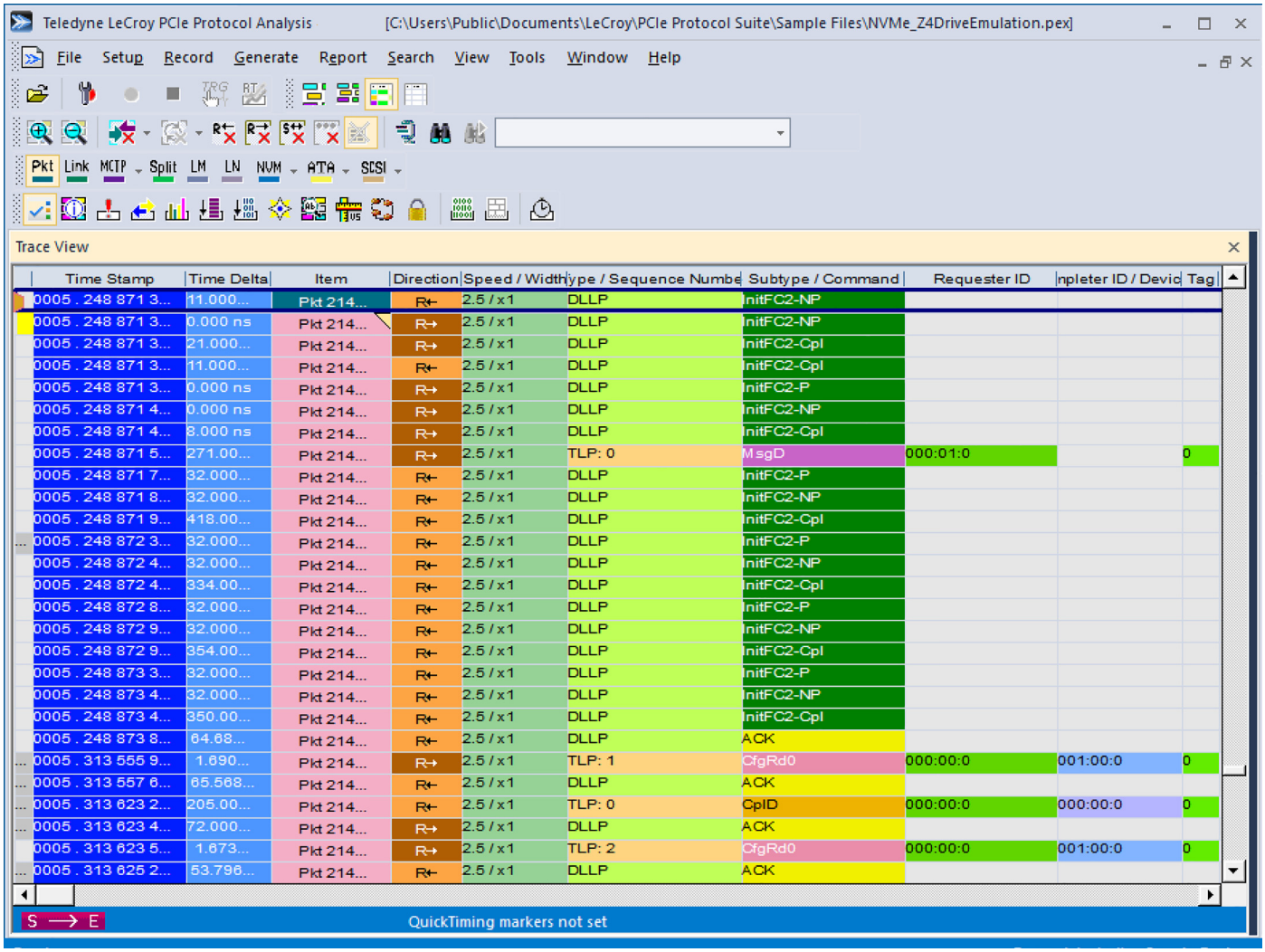


Figure 6.35: Default Set of Columns

6.10.2 Detail View and Spreadsheet View

In the Spreadsheet View, double-click a packet, transaction, or transfer, or select a field and then click on the toolbar, to display the Detail View (see Figure 6.36 on page 406).

To put a Detail View header as a column in the Spreadsheet View, drag the header to a column divider in the Spreadsheet View.

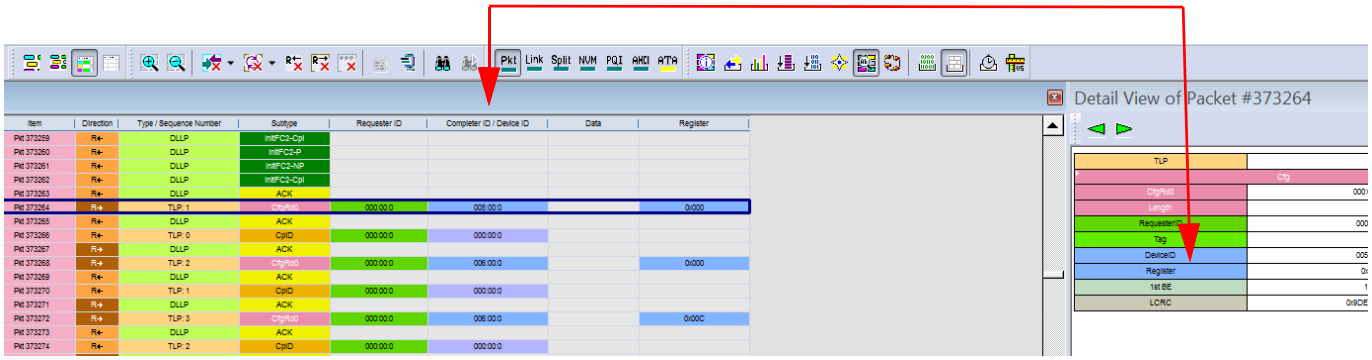


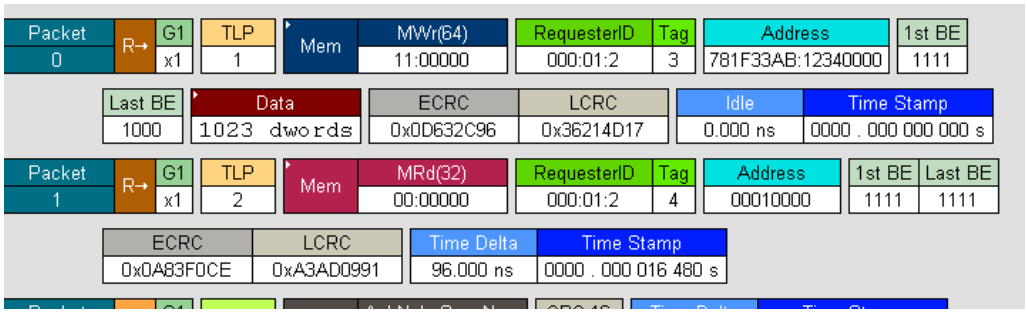
Figure 6.36: Detail View in Spreadsheet View

6.11 Decoding Traffic

The PCIe Protocol Analysis has several decode levels:

6.11.1 Packet

Packet level decode Pkt includes all TLP packets, DLLP packets, and all ordered sets.



Note: The PCI-E 3.0 (and 2.1 with Errata) specifications state that there are two formats of the AER capability structure, and the AER_CAP_VER field indicates if format 1 or format 2 is used.

The difference between format 1 and format 2 is whether or not the TLP Prefix Header section is present in the AER capability, even if it is not actually implemented.

This means that:

- If AER_CAP_VER = 1 and it is not a Root Port or RC Event Collector, there are 11

DWs (00h to 24h)in the total AER Capability structure.

- If AER_CAP_VER = 1 and it is a Root Port or RC Event Collector, there are 14 DWs (00h to 34h)in the total AER Capability structure.
- If AER_CAP_VER = 2 then, there are 18 DWs (00h to 44h) in the total AER Capability structure.

In fact, there are PCI-E 3.0 compliant devices that have AER_CAP_VER=1.

Example H/W:

A PCI-E 3.0 device that supports Multiple Header Recording, but does NOT support TLP Prefixes. This device is allowed to have AER_CAP_VER=1, and Multiple_Header_Recording_Capable=1

Therefore, the Teledyne LeCroy software decodes the Multiple_Header_Recording_Capable field regardless of the value of AER_CAP_VER.

Note: The Protocol Mode of the CATC View may show individual symbols grouped as a "packet" such as in the case where electrical symbols arrive before fast training sequences. Such group of symbols will also be reported in the summary. See Figure 6.37 on page 408.

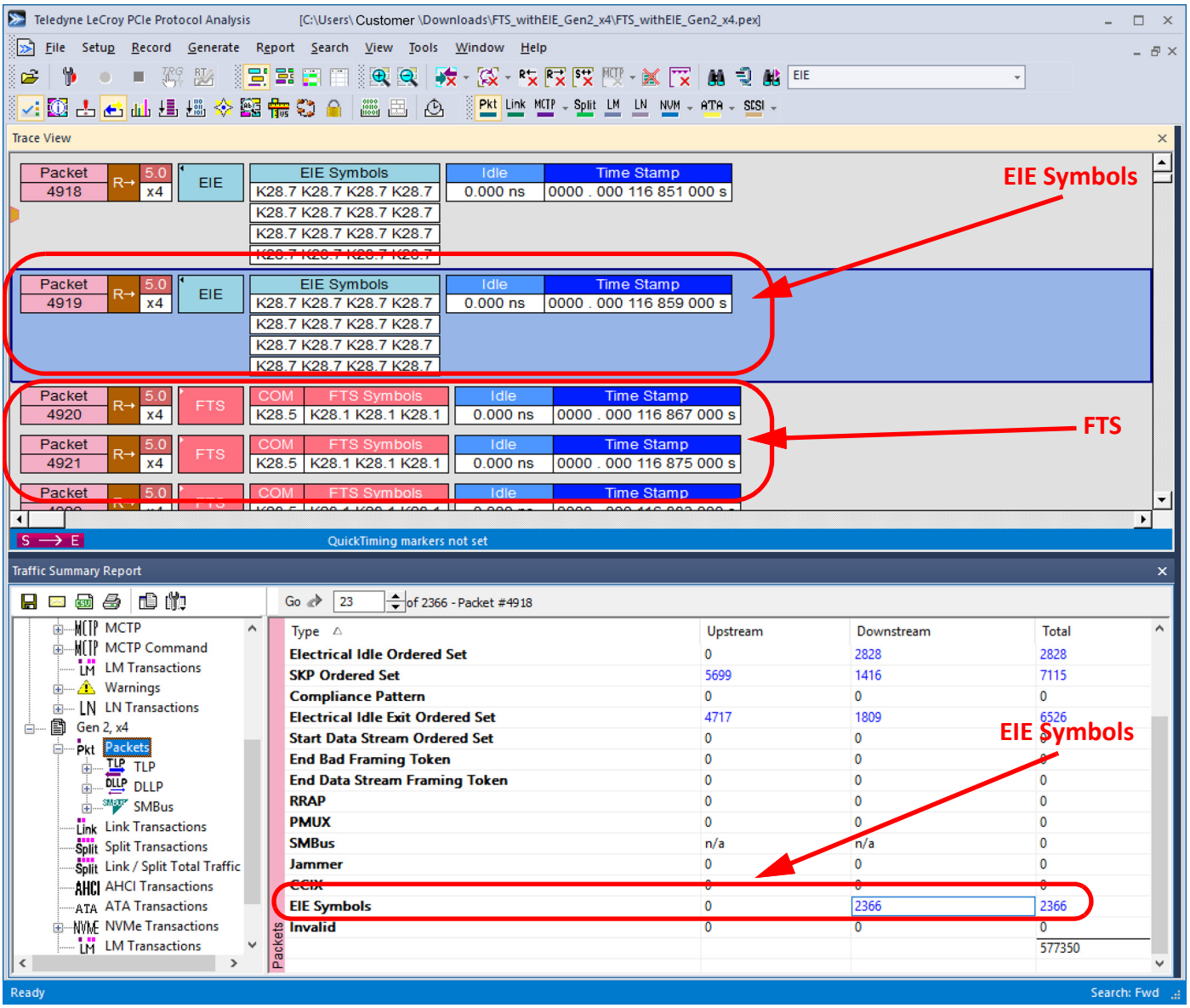
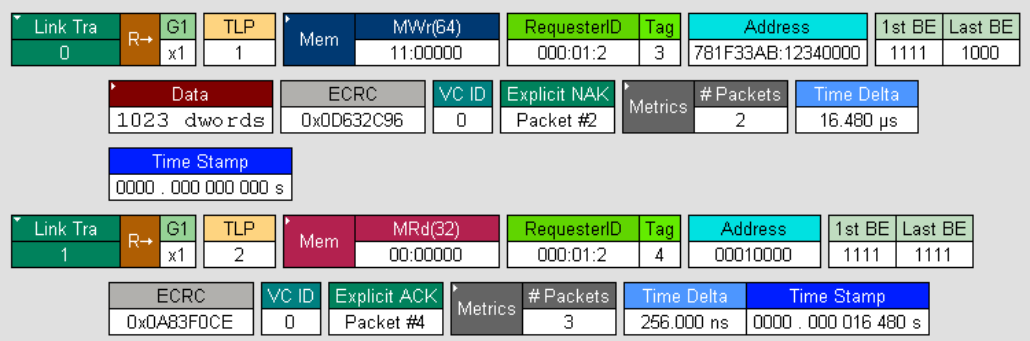


Figure 6.37: EIE Symbols Decoded before FTS

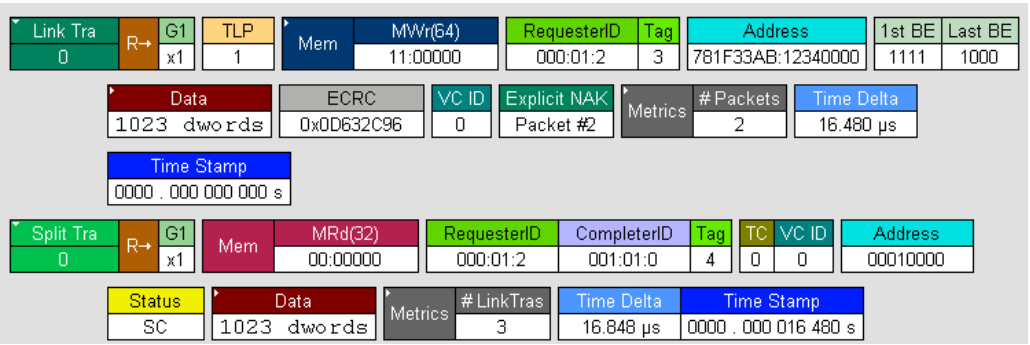
6.11.2 Link

Link level decode Link is composed of TLP packets matched with a corresponding ACK or NAK coming from the opposite direction.



6.11.3 Split

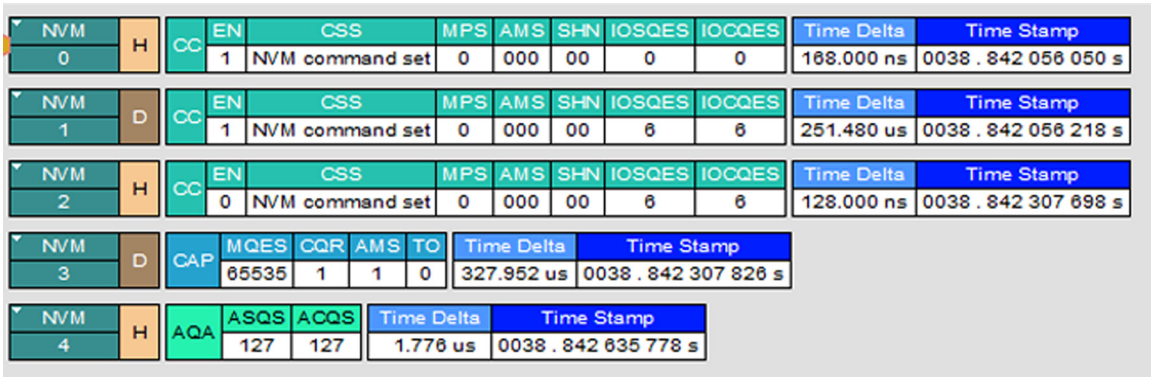
Split level decode Split is composed of two Link transactions, the Request TLP and the Completion TLP from the other direction.



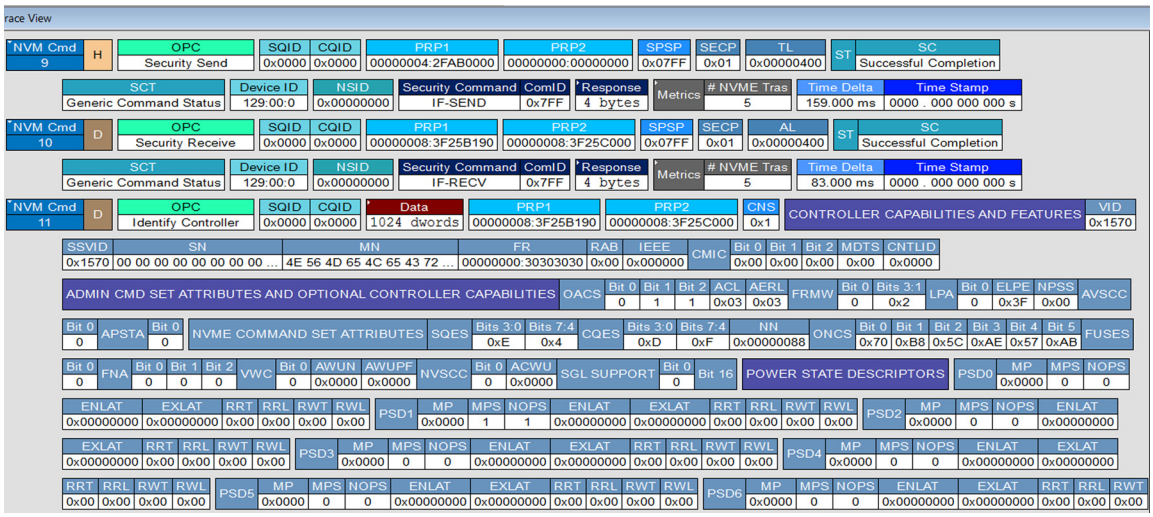
6.11.4 NVMe

To decode the NVMe protocol there are two levels available: NVMe Transaction level, which decodes the individual NVMe transactions from the PCI Express protocol and NVMe Command level, which gathers NVMe transactions into a single command. If the top level button NVM is selected, it will decode the NVMe Command level directly.

The NVMe Transaction level option displays NVMe transactions. PCIe Protocol Analysis decodes the storage commands starting from lower PCI Express Transaction Layer decodes. In the case of NVMe, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level and finally the NVMe Transaction decode level.



The NVMe Command level option displays NVMe Commands. The NVME commands decode all the lower level decodes first.



Note: As of software version 7.34, the NVMe decoding will be performed properly even if the ACK DLLPs have been filtered.

Note: As of software version 7.34, once the NVMe decoding has been applied, it will be kept in a separate temporary file not the Trace file (see "Trace File Structure" on page 201). The next time the trace is opened for review there will be no need to re-decode, making opening of the file in NVMe mode faster.

Note: As of software version 7.36 Beta, the NVMe decoding can handle multiple controller resets within the same recording.

6.11.4.1 NVMe: Device ID and Model Name Decoded

As of software version 7.34, the Device ID and Device Model Name field is displayed in the decoded command (see Figure 6.38 and Figure 6.39).

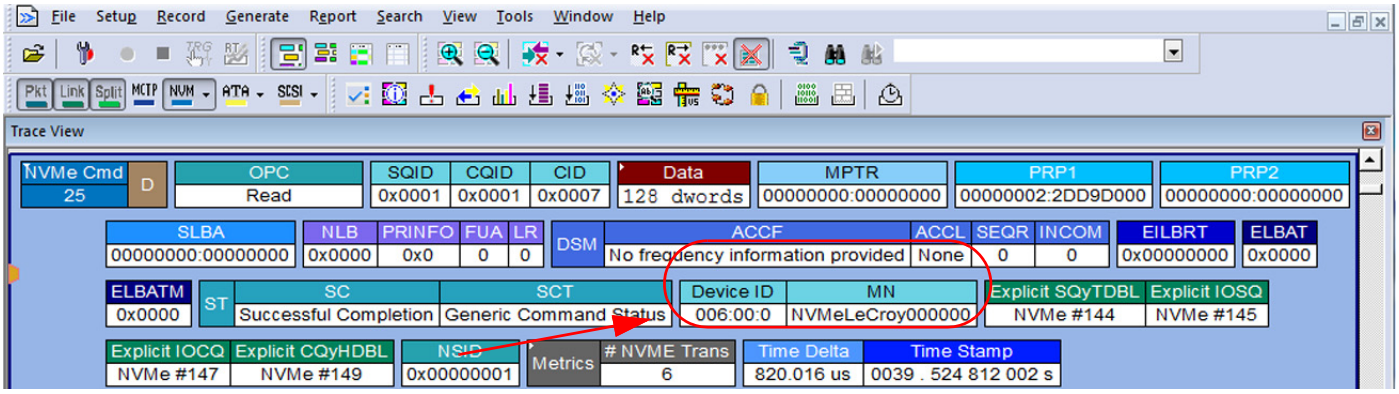


Figure 6.38: Device ID and Model Number Decoded from NVMe Trace

The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and NVMe transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu. See Figure 6.39.

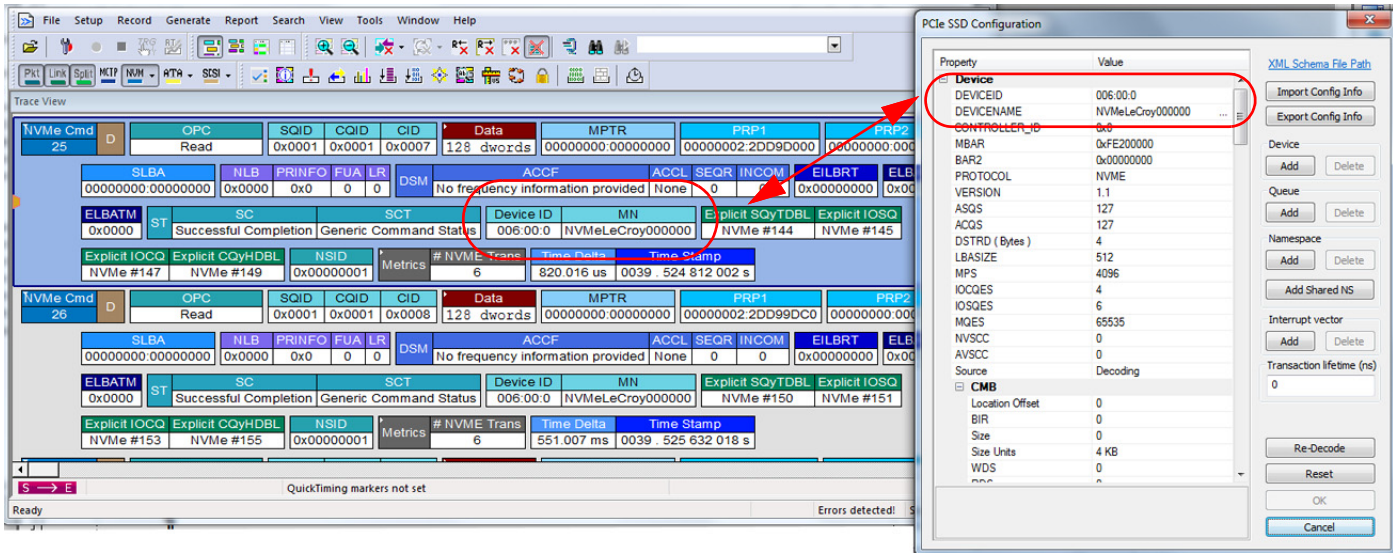
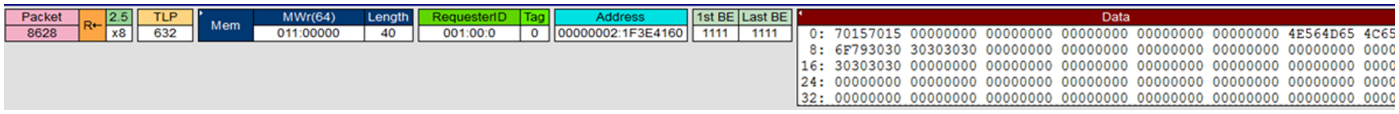


Figure 6.39: Device ID and Device Model Name Shown in SSD Configuration Dialog

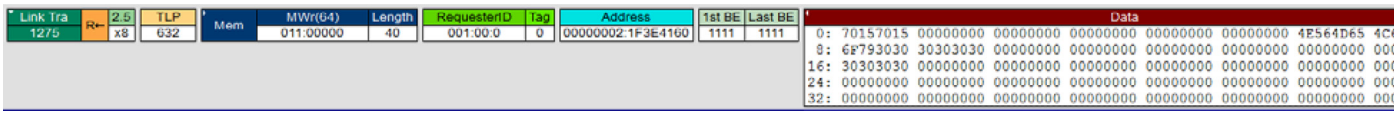
6.11.4.2 NVMe: Data Field on Packets

While the data field section displayed for a PCIe packet shows the actual payload for that PCIe packet (as shown below):

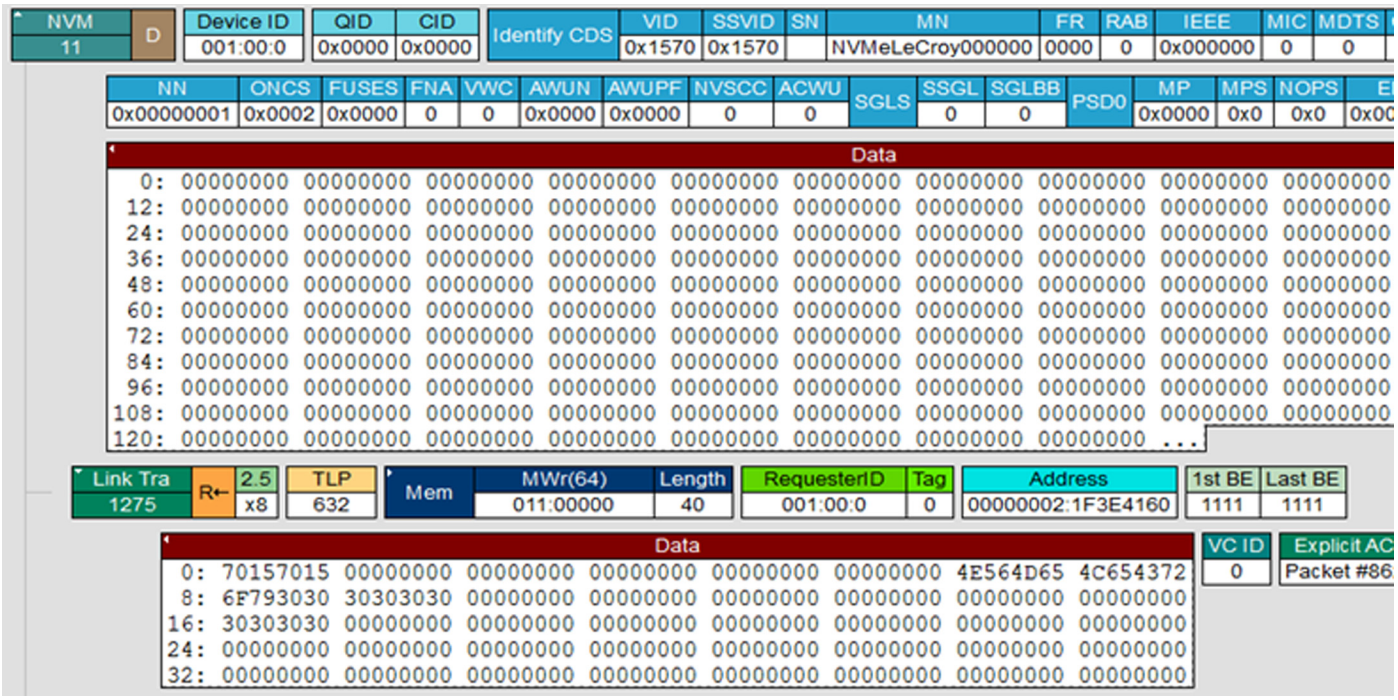


The content for this field changes depending on the decode level selected and the particular command decoded.

For example, at the PCIe transaction level, this field still reflects the PCIe payload field involved in the PCIe transaction (as shown below):

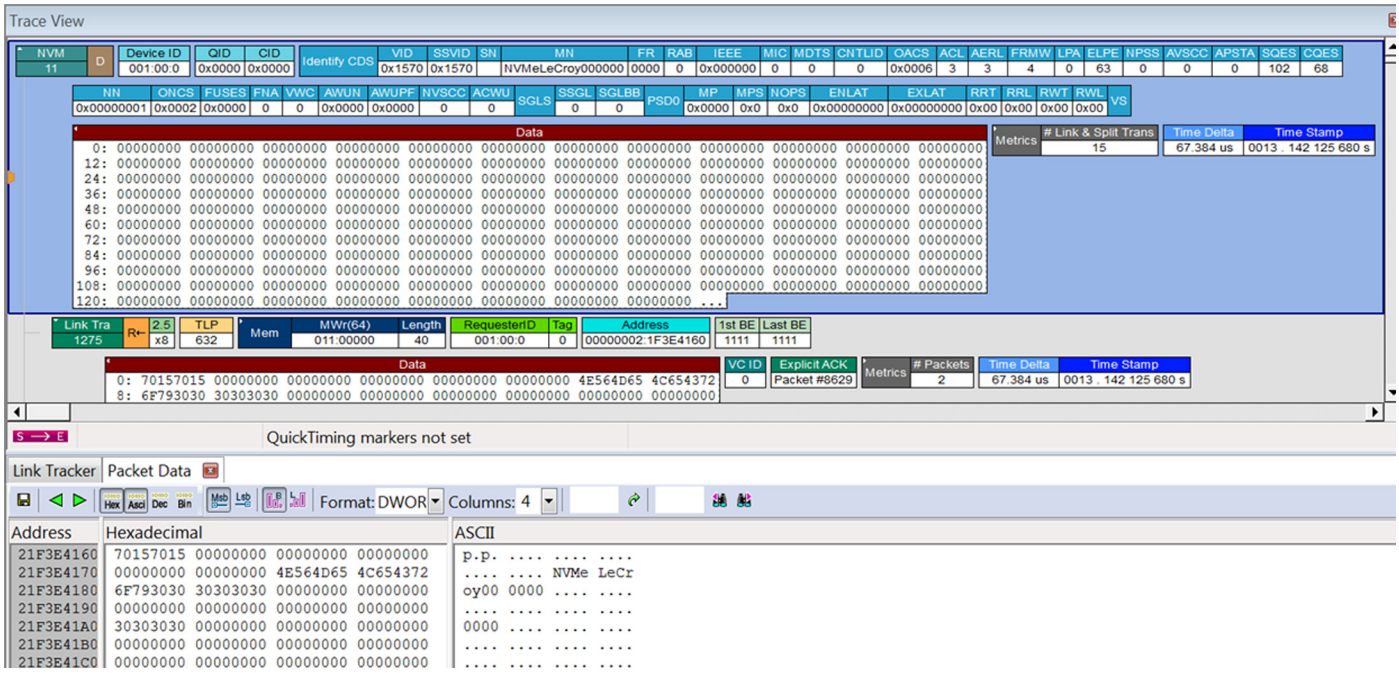


At the NVMe transaction level for identify command is shown below:



The data is shown according to NVMe specification. The portion of data that can be parsed into fields is parsed and drawn in named cells. The portion of data that cannot be parsed (i.e. 'vendor specific' portion is not parsed and is shown as a plain data).

In case you need to see this plain data (not parsed by named fields) the packet data view can be used. (as shown below):



6.11.4.3 NVMe: Trusted Computing Group Decode

Trusted Computing Group decodes are shown using the NVMe Command Level if they are present in the trace, as shown in Figure 6.40.

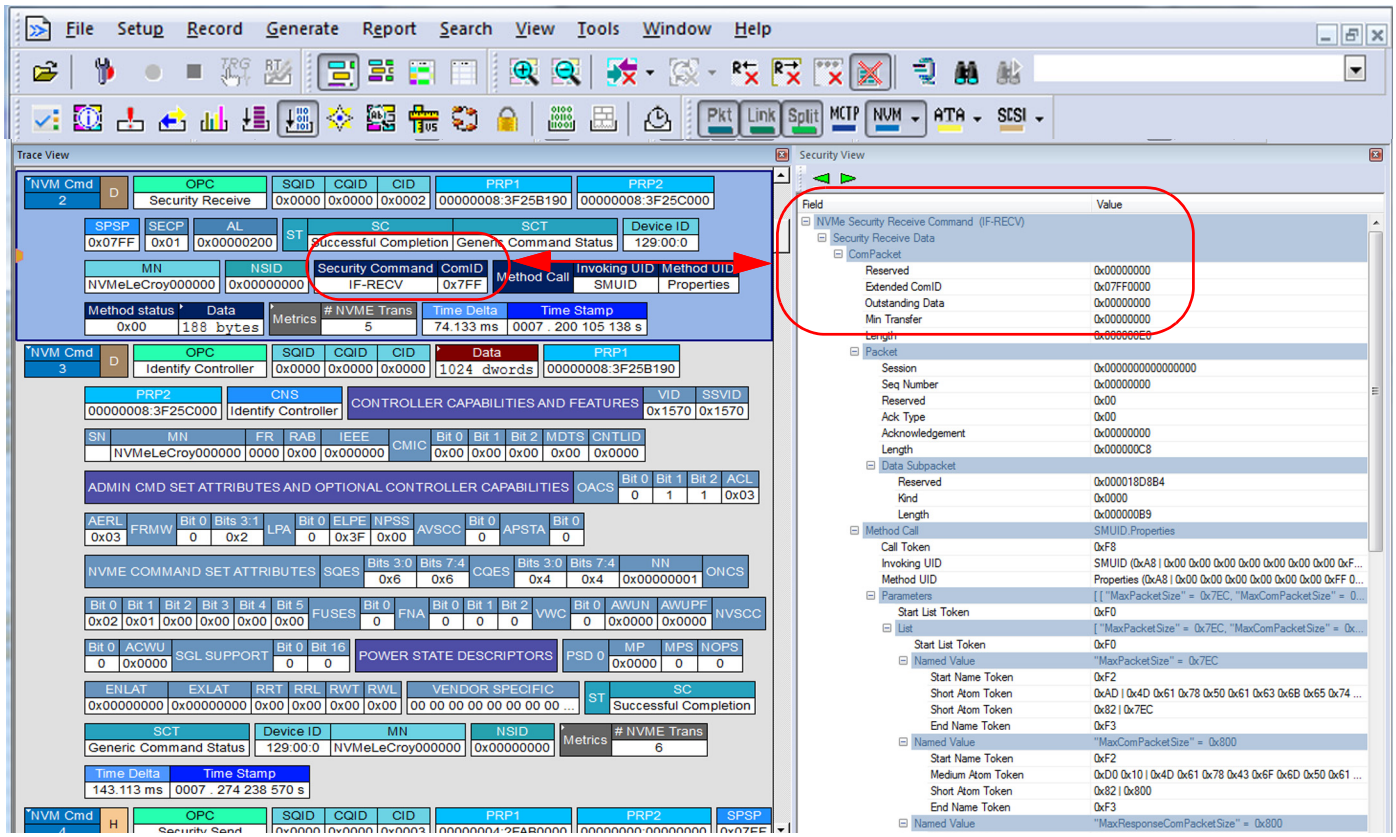


Figure 6.40: NVMe Command with TCG Details

6.11.4.4 The Opal Storage Specification

The Opal Storage Specification is a set of specifications for features of data storage devices (such as disk drives) that enhance their security. For example, it defines a way of encrypting the stored data so that an unauthorized person who gains possession of the device cannot see the data. That is, it is a specification for self-encrypting drives (SED).

The specification is published by the Trusted Computing Group Storage Workgroup.

The Opal SSC (Security Subsystem Class) is an implementation profile for Storage Devices built to:

- Protect the confidentiality of stored user data against unauthorized access once it leaves the owner's control (involving a power cycle and subsequent deauthentication).
- Enable interoperability between multiple SD vendors.

NVMe: TCG Opal Decoded

The PCIe Protocol Software can decode and display Opal TCG fields. See Figure 6.41.

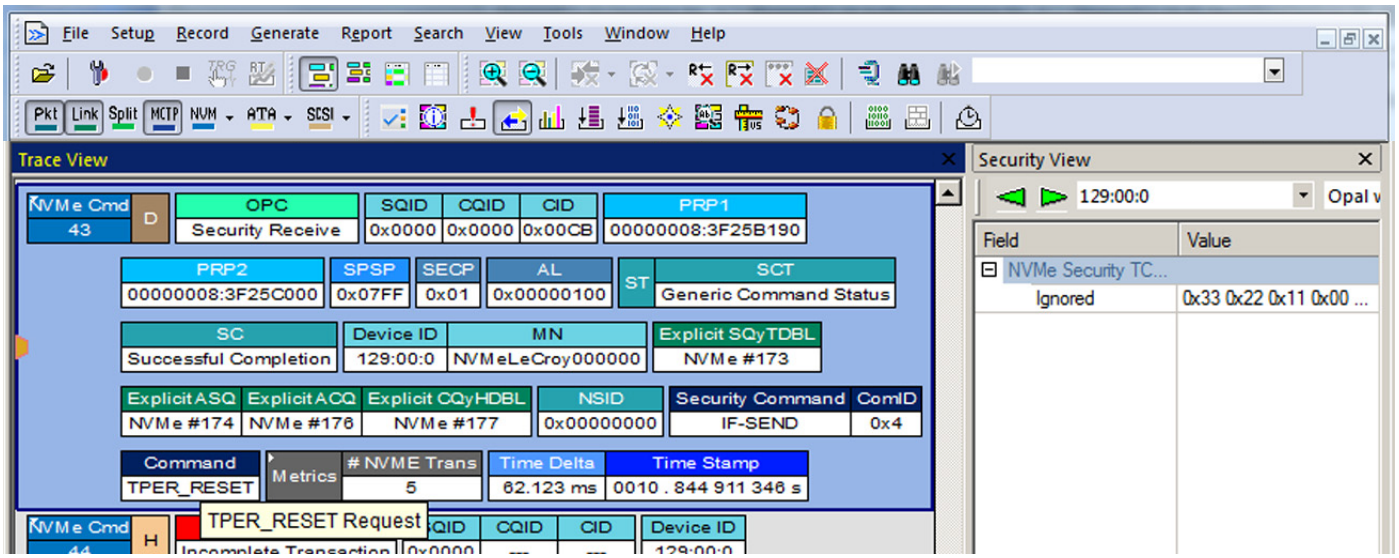


Figure 6.41: NVMe Trace: Opal TCG Security Fields Decoded

A more detailed view of the security field is shown in Figure 6.42 on page 415.

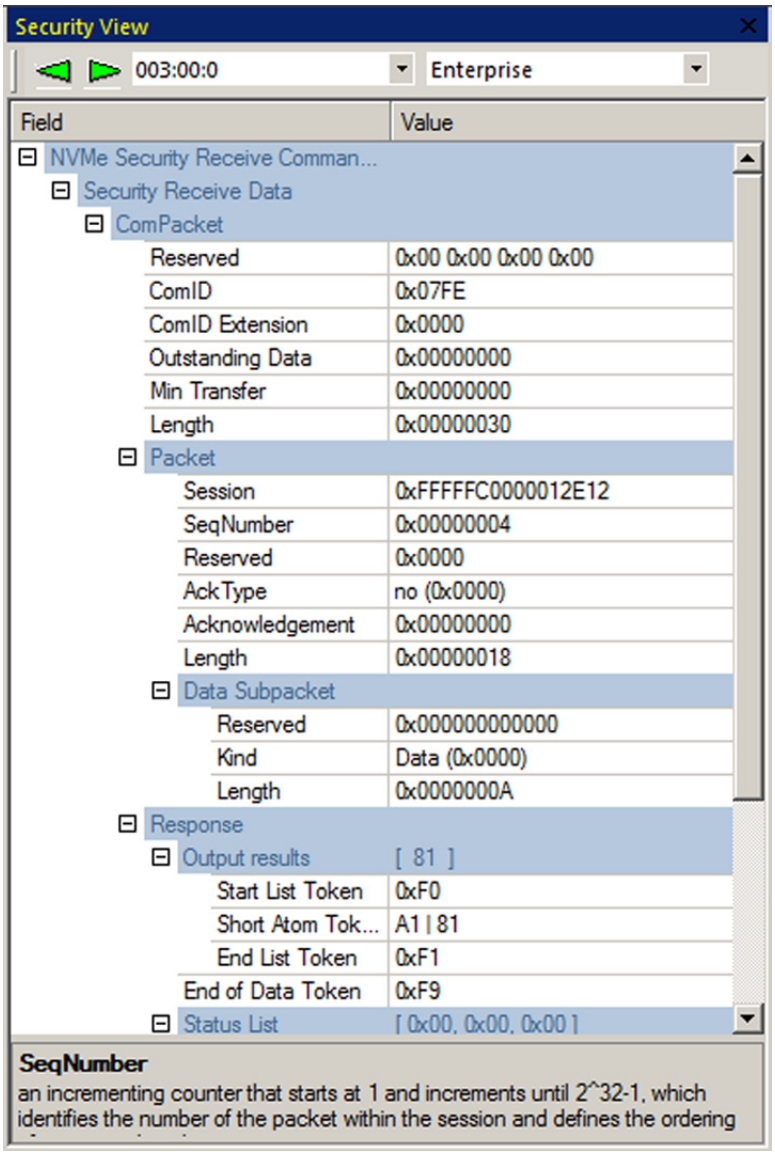


Figure 6.42: NVMe Trace: Opal TCG Security Fields Decoded in Detail

6.11.4.5 Opalite Version 0.1: Decoded

The PCIe Protocol Analysis software can decode the TCG transaction: Opalite Security Version 0.1 (as shown in Figure 6.43 and Figure 6.44 on page 417 below):

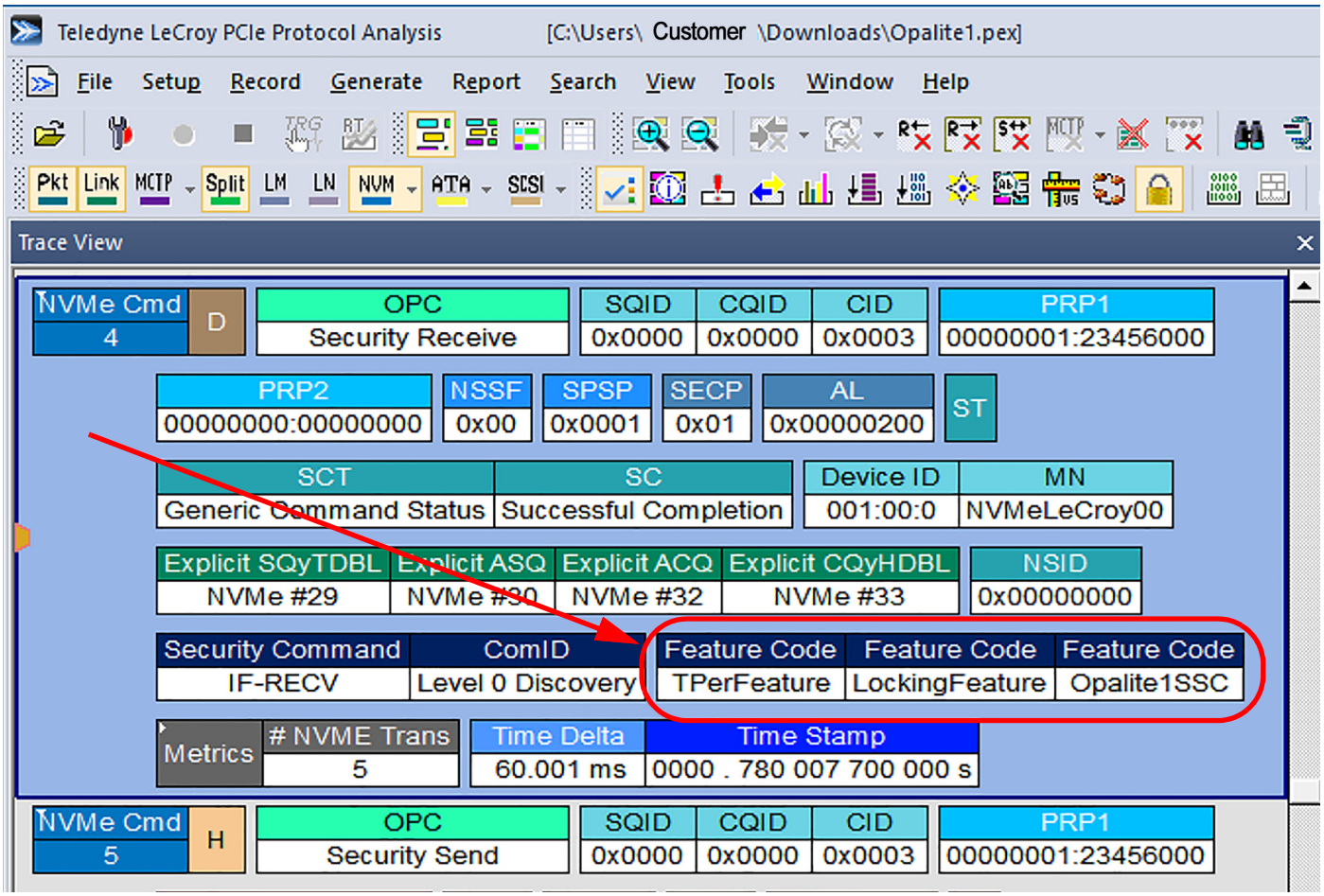


Figure 6.43: NVMe Trace: Opalite v0.1 TCG Security Fields Decoded

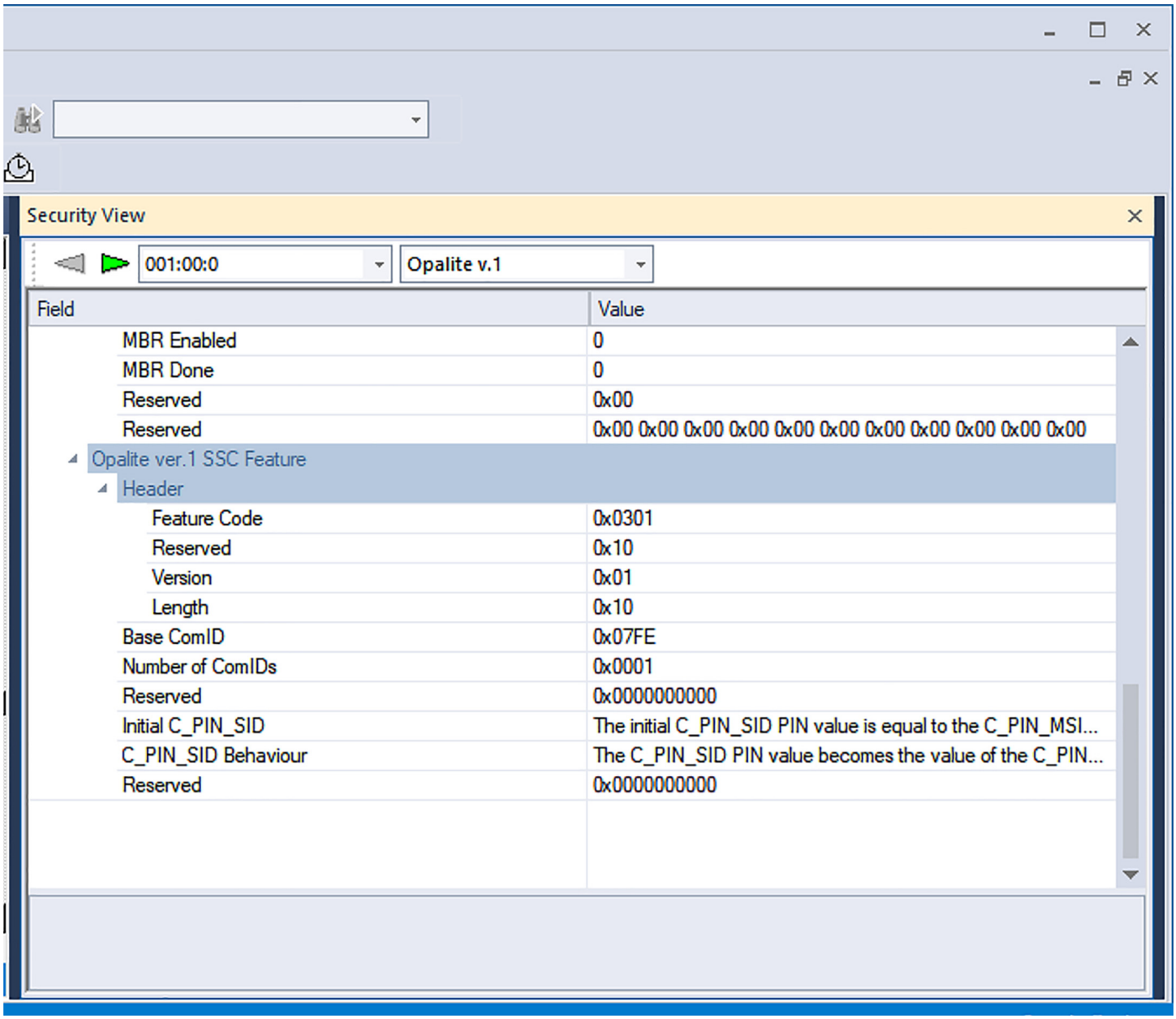


Figure 6.44: NVMe Trace: Opalite v0.1 TCG Security Fields Decoded -> Details

6.11.4.6 NVMe: Command IOPS and Doorbell Statistical Information

IOPS and Doorbell statistical information can be displayed from an NVMe Trace by selecting an NVMe Packet with a Read or Write Command and viewing the Metrics box. See Figure 6.45 and Figure 6.46 on page 418.

The Doorbell statistics include:

- SQdoorbell to CQdoorbell,
  (time from Submission Doorbell to Completion Doorbell)
- SQDoorbell to CQentry,
  (time from SQ doorbell to command completion)
- SQentry to CQentry,
  (time from submission command to command completion

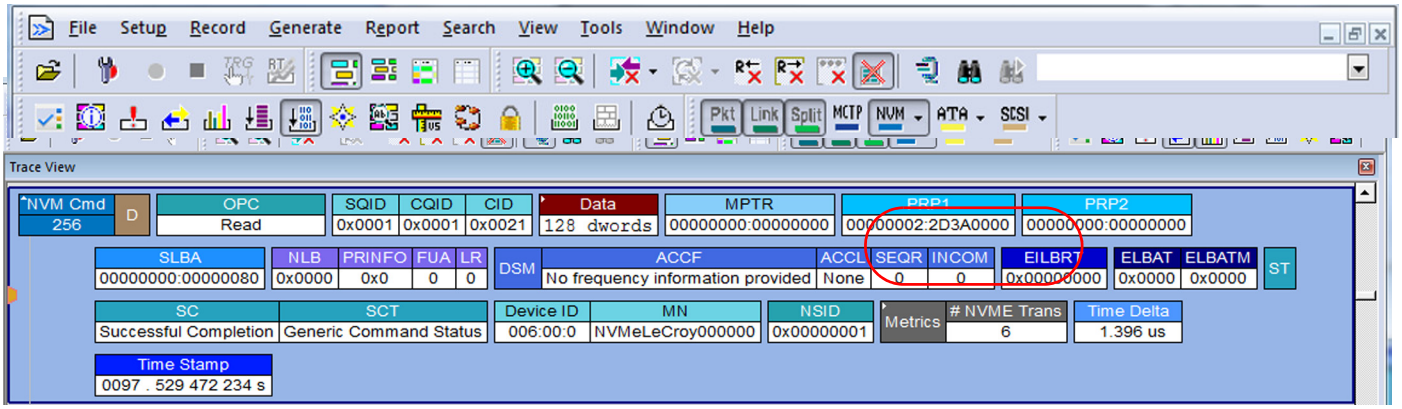


Figure 6.45: NVMe Read Command Packet with Metrics Box

Move the cursor over the Metrics box to display the information about the NVMe Command. See Figure 6.46.

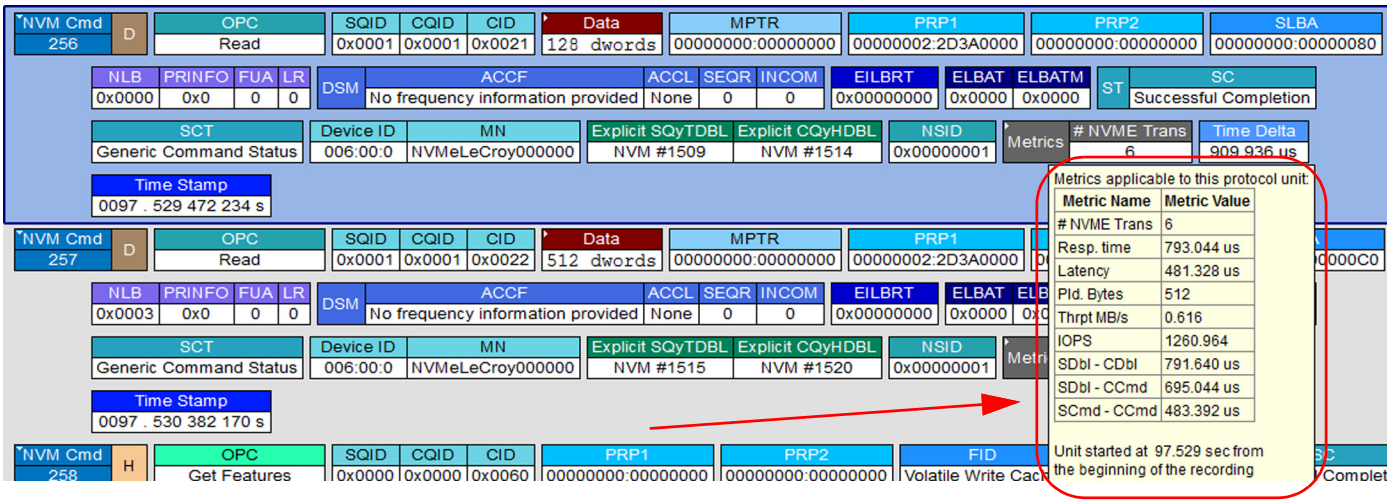


Figure 6.46: NVMe Read Command Packet with Metrics Displayed

If you click on the white arrow in the Metrics box, the information about the packet will be displayed in the Trace. See Figure 6.47.

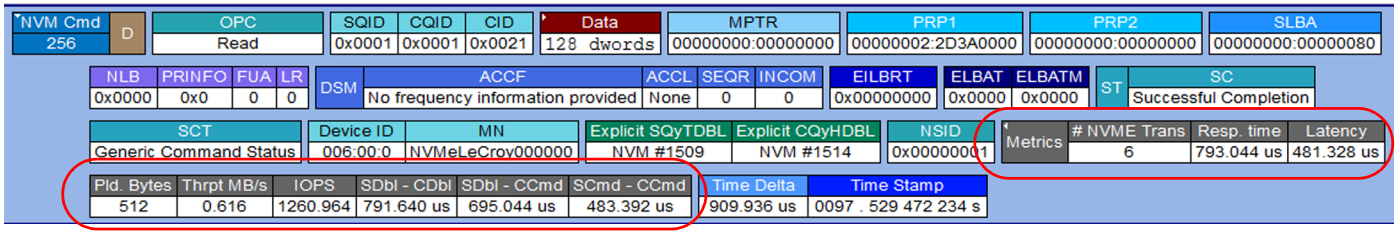


Figure 6.47: NVMe Read Command Packet with Metrics Displayed in Trace

The IOPS value is defined when you move the cursor over the IOPS box. See Figure 6.48.

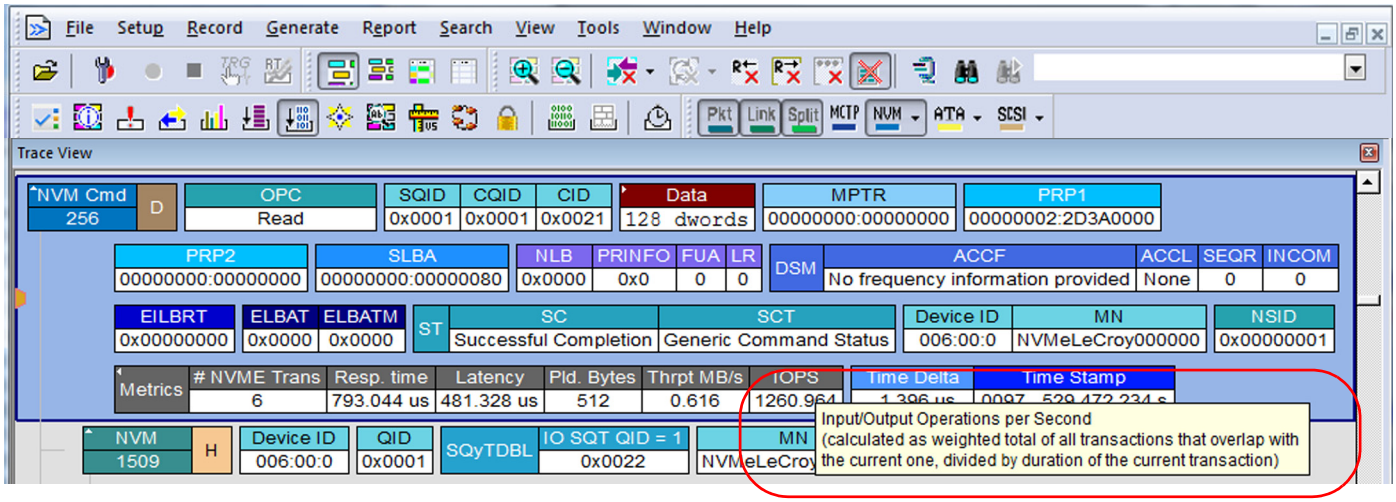


Figure 6.48: NVMe READ Command: IOPS Defined

The NMV Command IOPS can be viewed in Bus Utilization mode by selecting the Bus Utilization icon in the toolbar and selecting the Graph areas icon. See Figure 6.49.

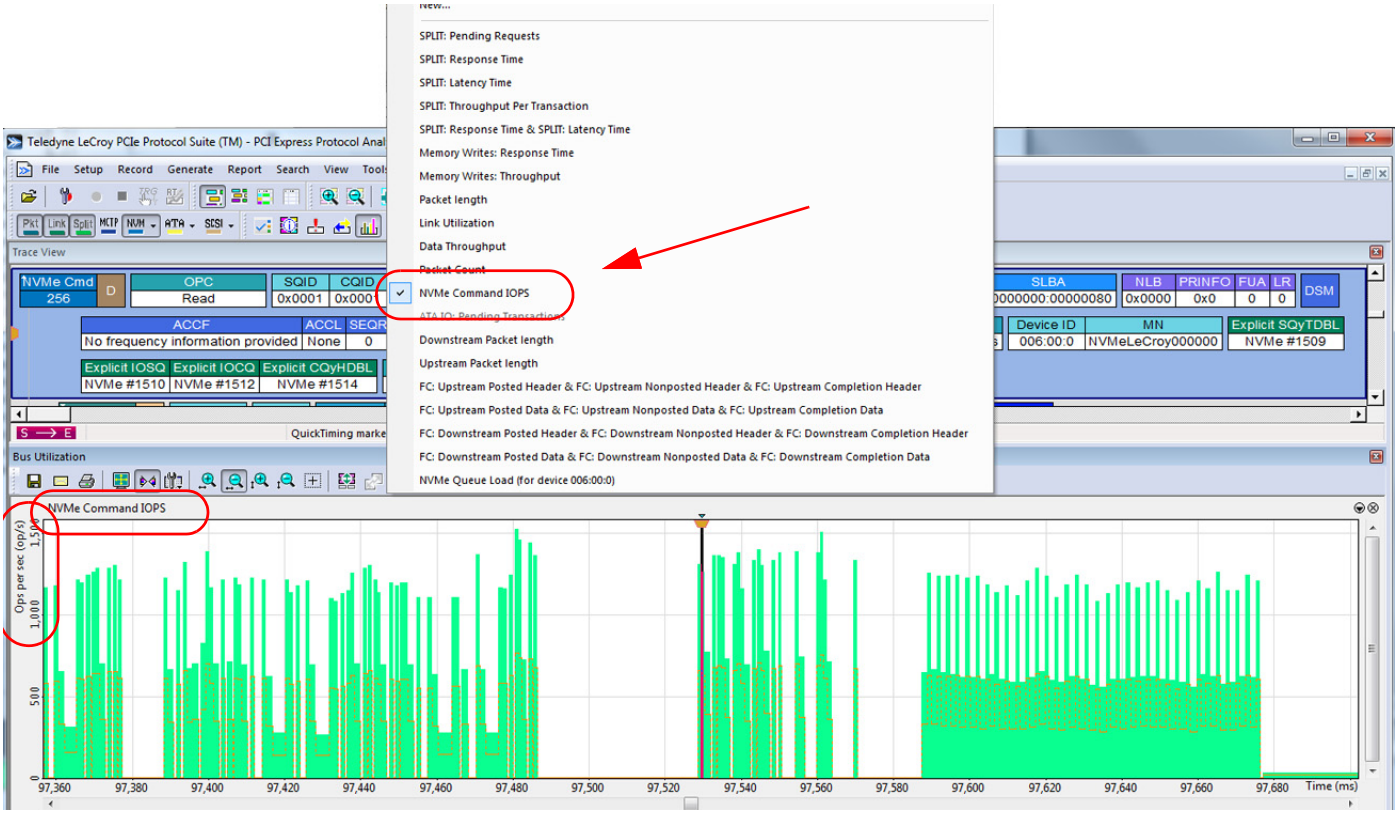


Figure 6.49: NVMe READ Command: Bus Utilization -- IOPS

NVMe Command IOPS is also displayed in the Spreadsheet and Detailed Views. See Figure 6.50.

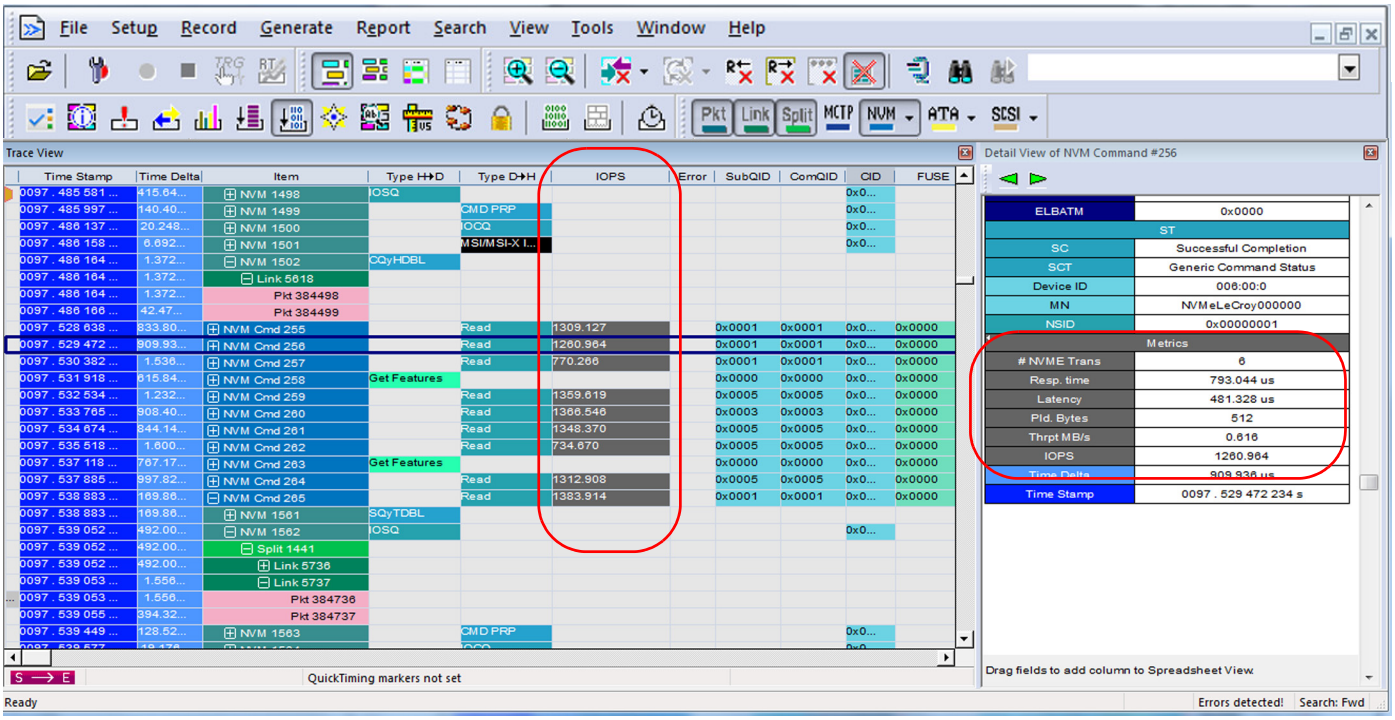


Figure 6.50: NVMe READ Command: IOPS Statistics

6.11.4.7 NVMe: Decode for Doorbells

Each type of doorbell's cell of an NVMe command is able to represent 1 of 4 states:

- Explicit (NVMe command contain concrete DBL). See Figure 6.51 on page 422.
- Implicit (Some doorbells implicitly complete previous commands. Such commands do not have a doorbell that can be associated one to one. This will be indicated in the trace.)
- Missing (NVMe cmd Is Incomplete, and DBL missing)
- Filtered (DBL is filtered out in Recording rules)

Tooltips:

- For SQyTDBL: Command was explicitly/implicitly initiated by SQyTDBL in NVMe #number (See Figure 6.51 on page 422)
- For CQyHDBL: Command was explicitly/implicitly finished by CQyHDBL in NVMe #number
- For Missing Doorbells: Doorbell is missing
- For Filtered: Doorbells are filtered out

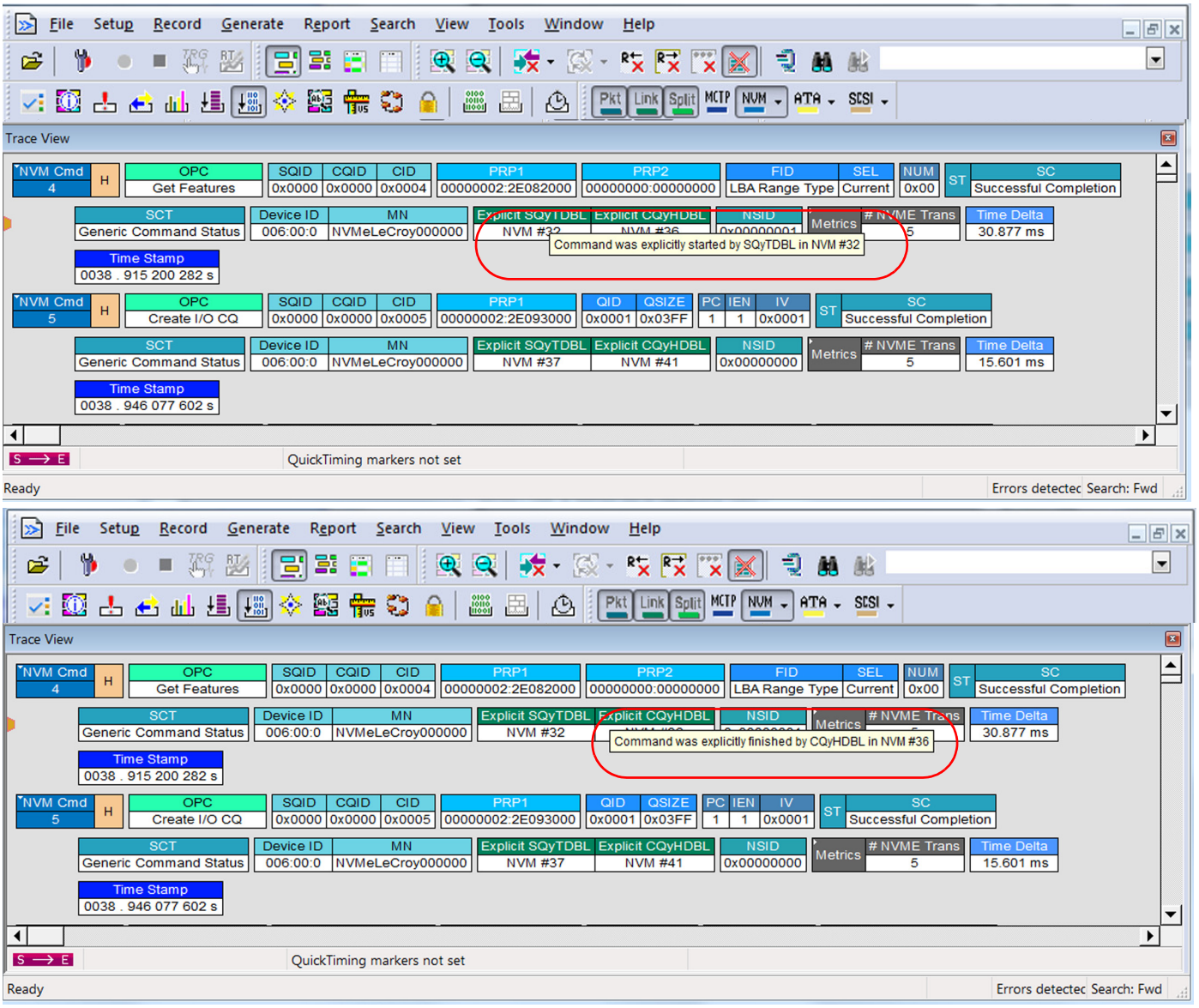


Figure 6.51: NVMe Decoding: Example of Explicit Doorbell in Trace with Tool Tips

6.11.4.8 Time Stamp from Implicit Start

The time stamp for an NVMe command can either be referenced from the recorded trace start time (see Figure 6.52) or from the implicit start of the command (see Figure 6.53). If you right click on the Time Stamp, the Time Stamp Context Menu will pop up. This allows you to Check or Uncheck the "Calculate Timestamp from implicit start if present" box.

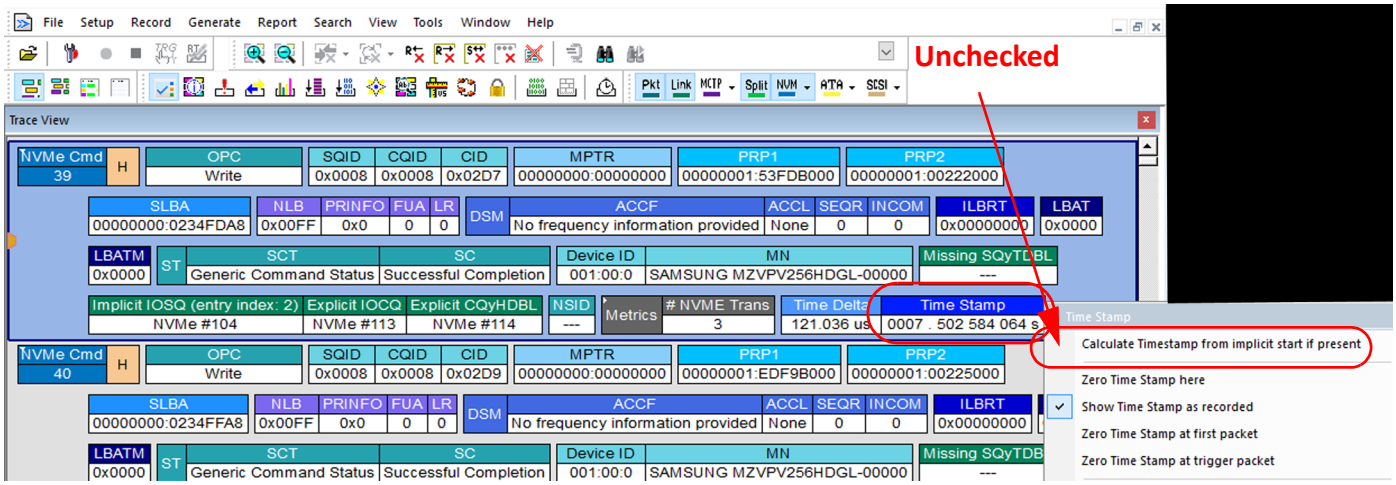


Figure 6.52: Timestamp Referenced from Start of Trace = 7.502584064 seconds

If you select "Calculate Timestamp from implicit start if present" you'll get the following results. In this case, the Implicit Start was earlier in the trace than the NVMe command so the timestamp for the NVMe command is earlier (see Figure 6.53).

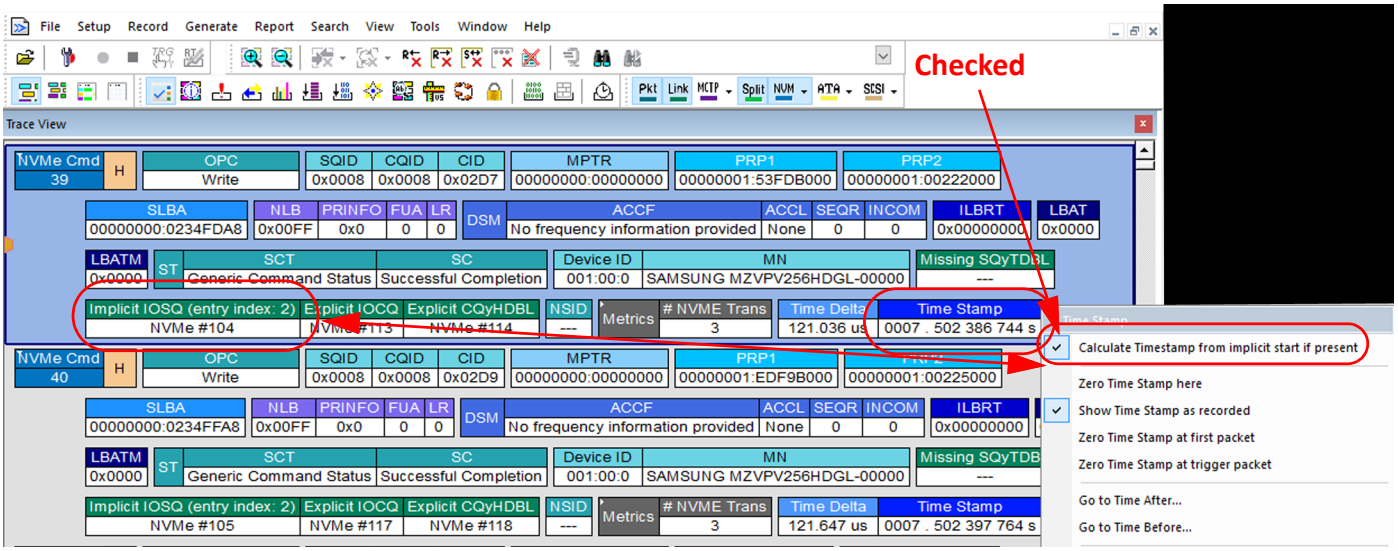


Figure 6.53: Timestamp Referenced from the Implicit Start = 7.502386744 seconds

6.11.4.9 NVMe Commands and Transactions: Data Throughput

Data Throughput is defined as the Payload divided by response time, expressed in MB per second (MB = 1024*1024 bytes) for both Commands and Transactions. See Figure 6.54 and Figure 6.55.

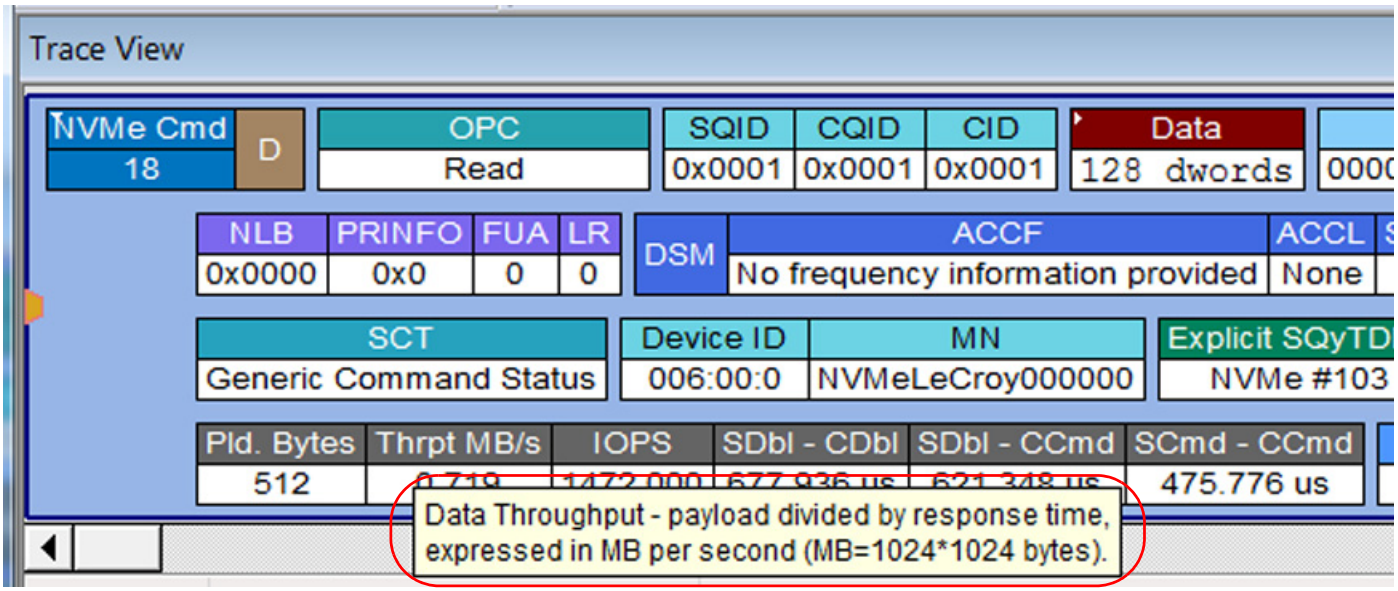


Figure 6.54: NVMe Command: Data Throughput

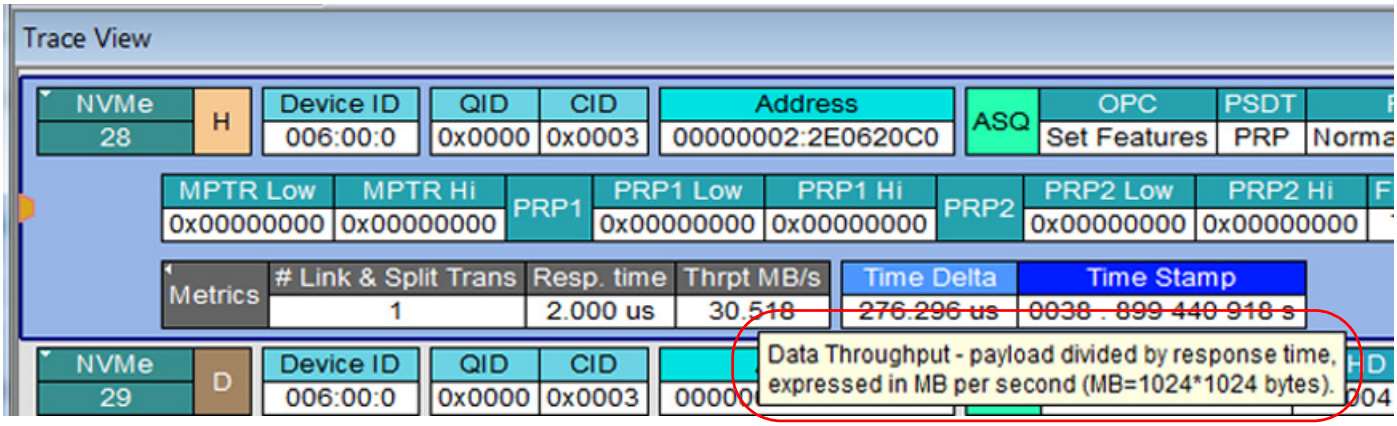


Figure 6.55: NVMe Transaction: Data Throughput

6.11.4.10 NVMe Decoding vs. NVMe Specification

After decoding an NVMe Trace you can view both the NVME data traffic in the Trace View as well as formatted per the NVMe Specification. The NVMe Specification View is brought up by selecting the NVMe Specification icon  in the tool bar (see Figure 6.56).

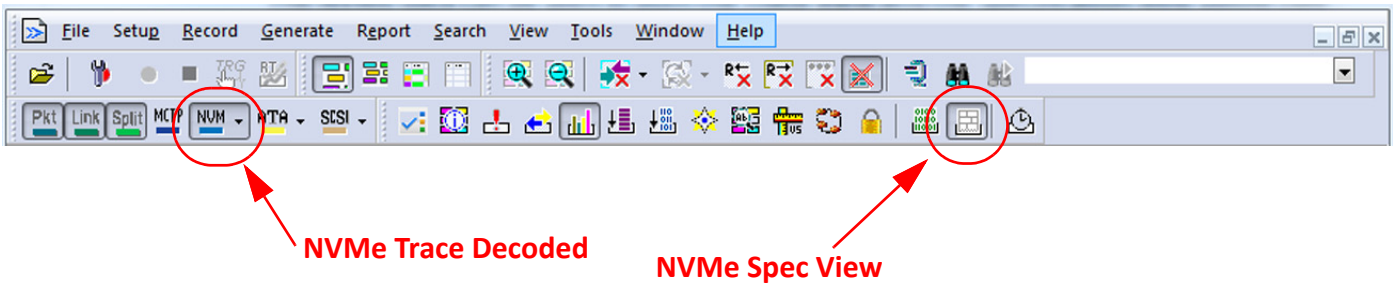


Figure 6.56: PCIe Protocol Analysis Toolbar -> NVMe Specification View

The NVMe data can be seen in both the Trace View and the Specification view below (see Figure 6.57 and Figure 6.58 on page 426).

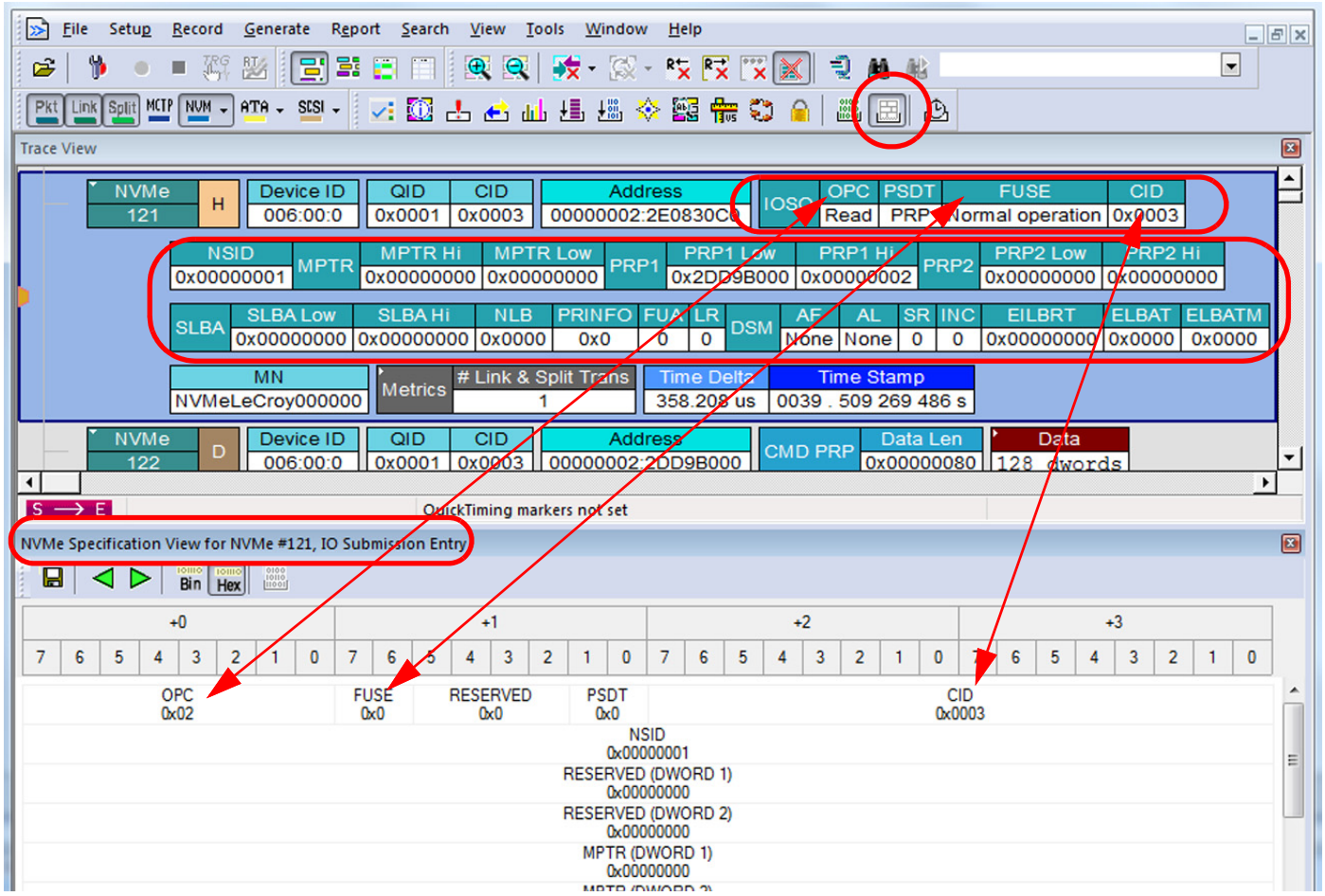


Figure 6.57: Decoding NVMe Trace -> Trace View vs. Spec View (Part 1)

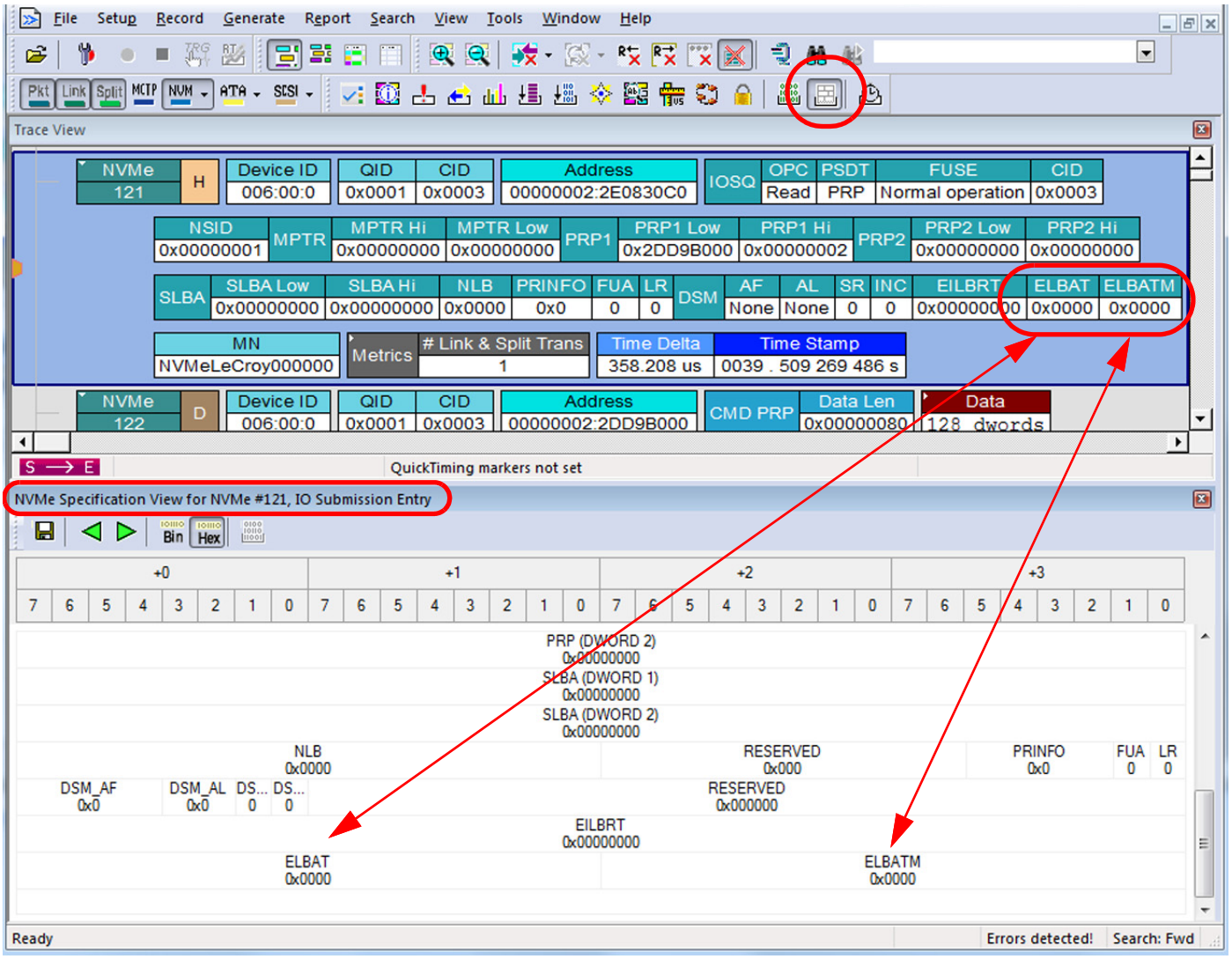


Figure 6.58: Decoding NVMe Trace -> Trace View vs. Spec View (Part 2)

If you move the cursor over a specific data block a Tool Tip will pop up with more information about the data block. See Figure 6.59

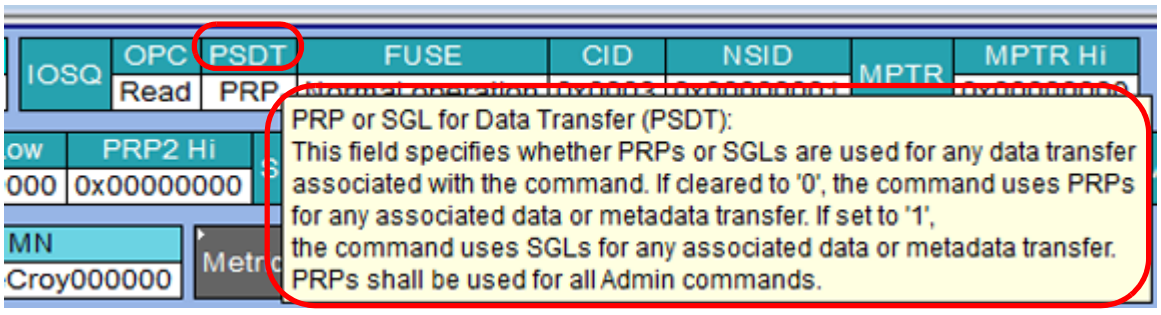


Figure 6.59: NVMe Specification: Trace View Tool Tip

Similar Tool Tips are available in the NVMe Specification View. See Figure 6.60 on page 427.

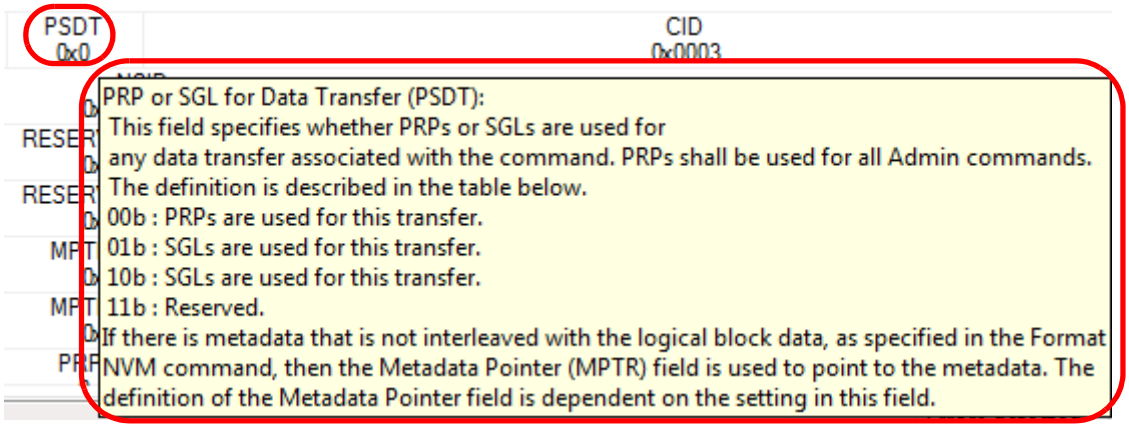


Figure 6.60: NVMe Specification View: Tool Tip

The NVMe Specification View is also available from the Main Toolbar under Report -> NVMe Specification. See Figure 6.61.

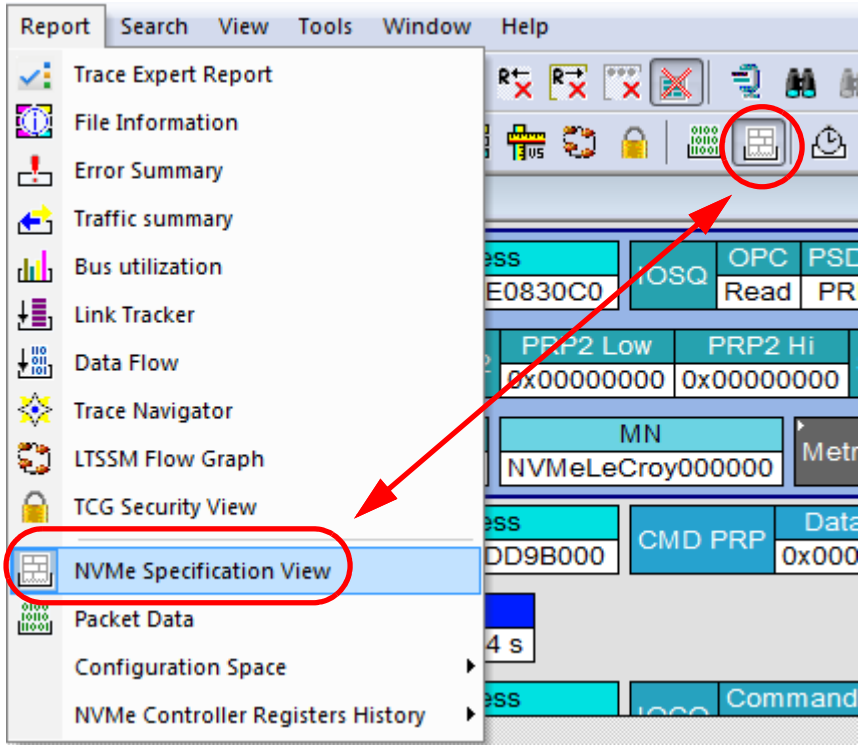


Figure 6.61: Report: NVMe Specification

6.11.4.11 NVMe Controller Register

To view the NVMe Controller Registers perform the following steps:

1. Load a trace with NVMe data traffic.
2. Select Packet, Link, Split, NVMe, Hide Unrelated Traffic and View -> Wrap to produce the following display (see Figure 6.62).

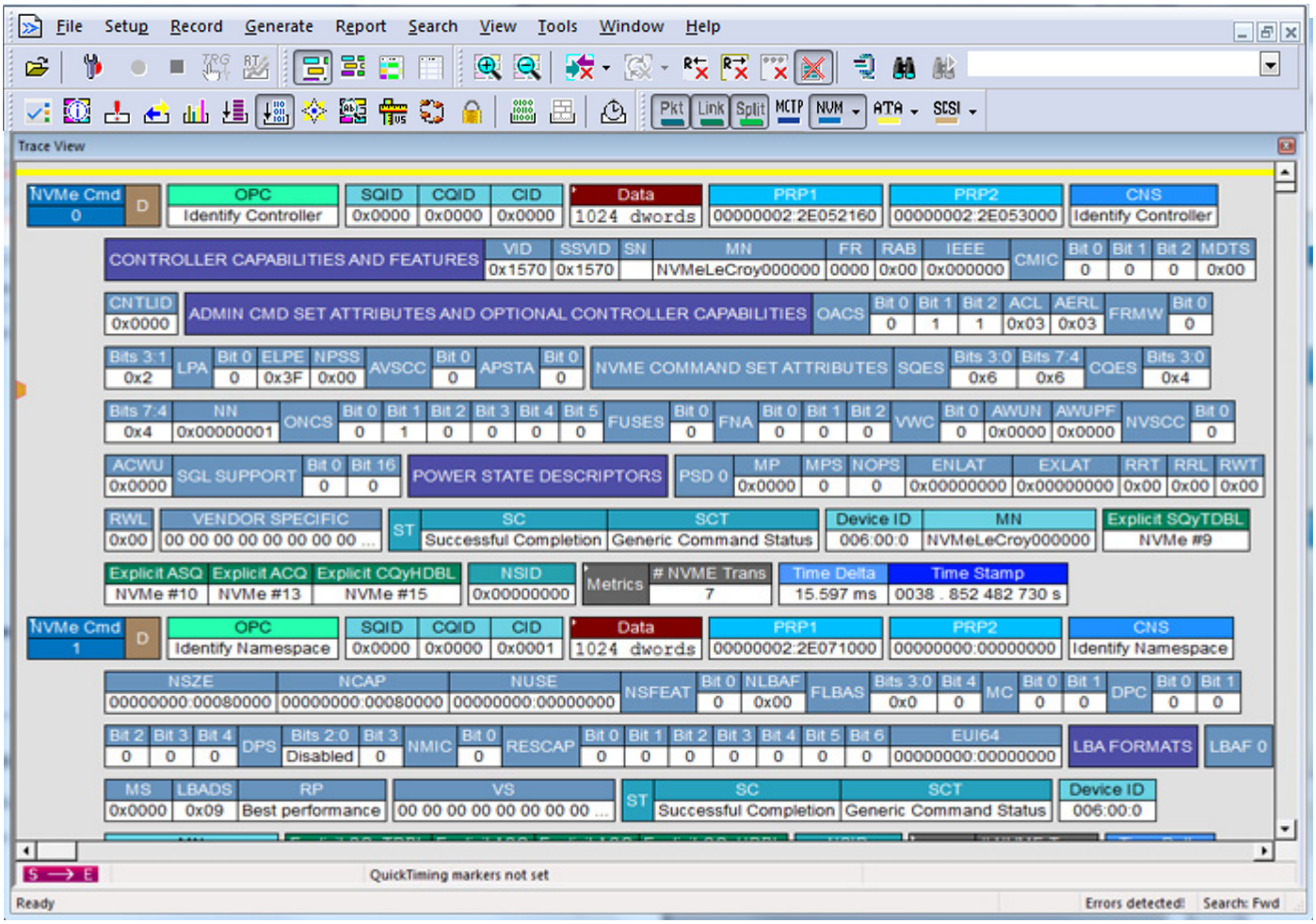


Figure 6.62: NVMe Trace Loaded

3. Select Reports -> NVMe Controller Registers History (see Figure 6.63 on page 429).

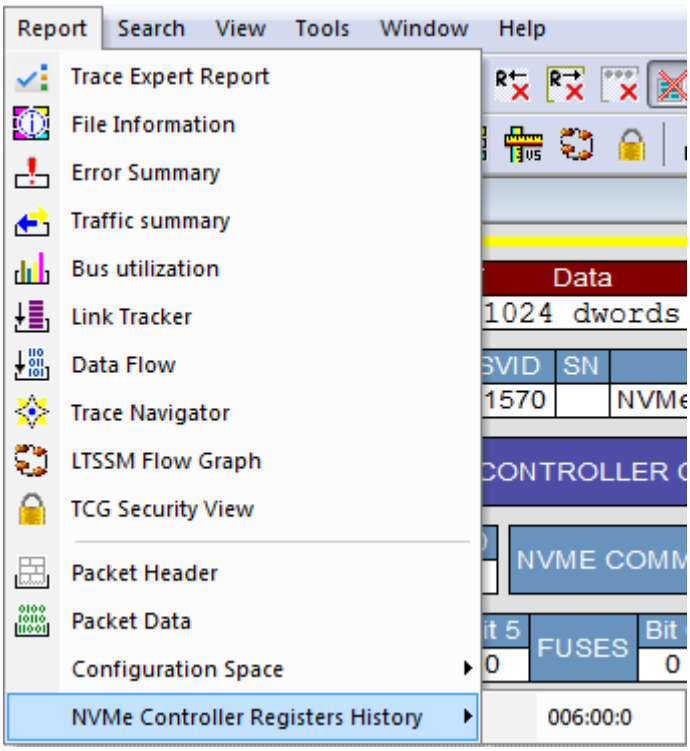


Figure 6.63: Reports -> NVMe Controller Registers History

4. Select the time shown (006:00:0) and the following display will pop up. See Figure 6.64 on page 430.

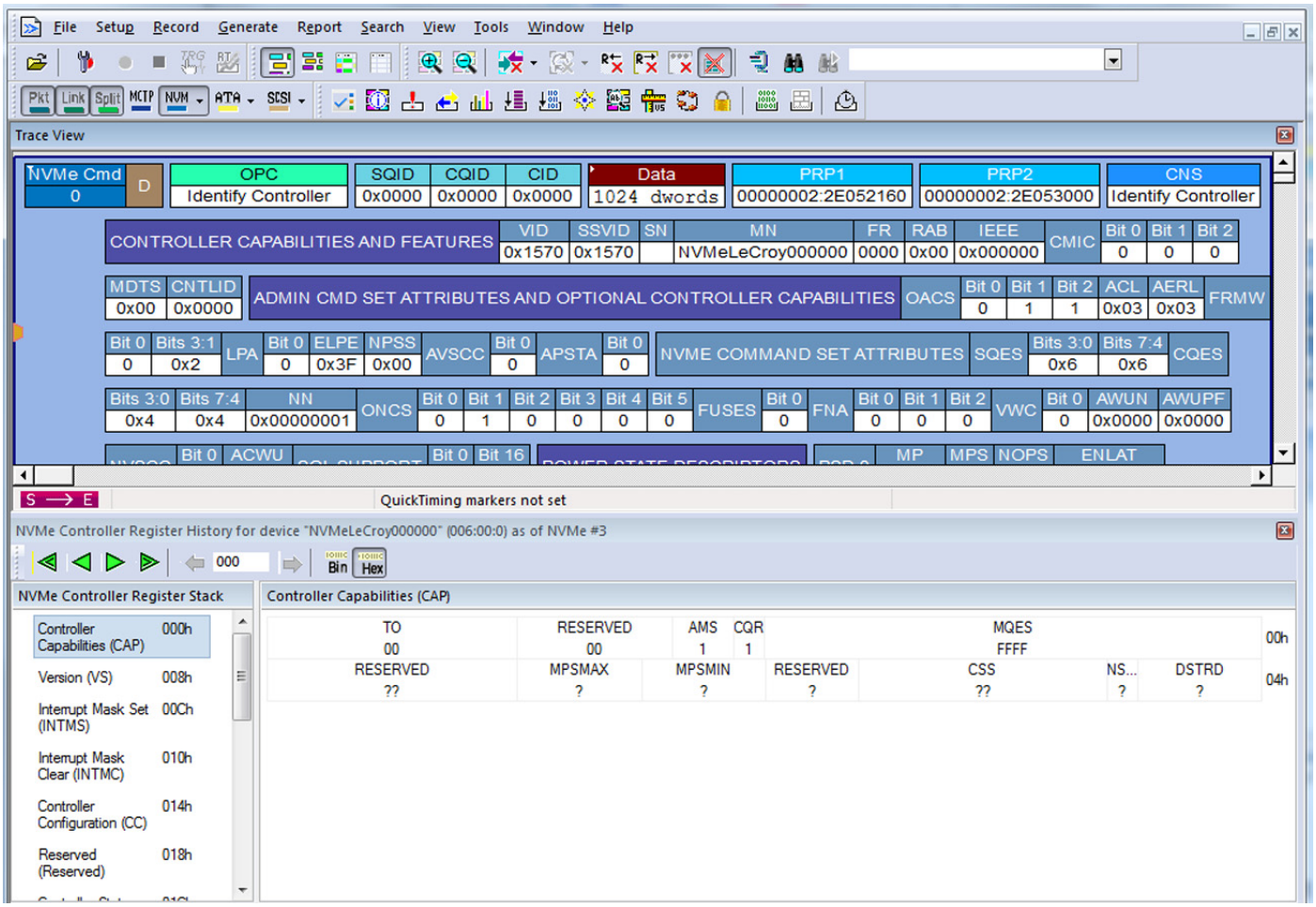


Figure 6.64: Reports -> NVMe Controller Registers History Displayed

5. If you zoom in on the green arrows, you can:
   a. Go to the First NVMe Controller Register
   b. Go to the Previous NVMe Controller Register
   c. Go to the Next NVMe Controller Register
   d. Go to the Last NVMe Controller Register

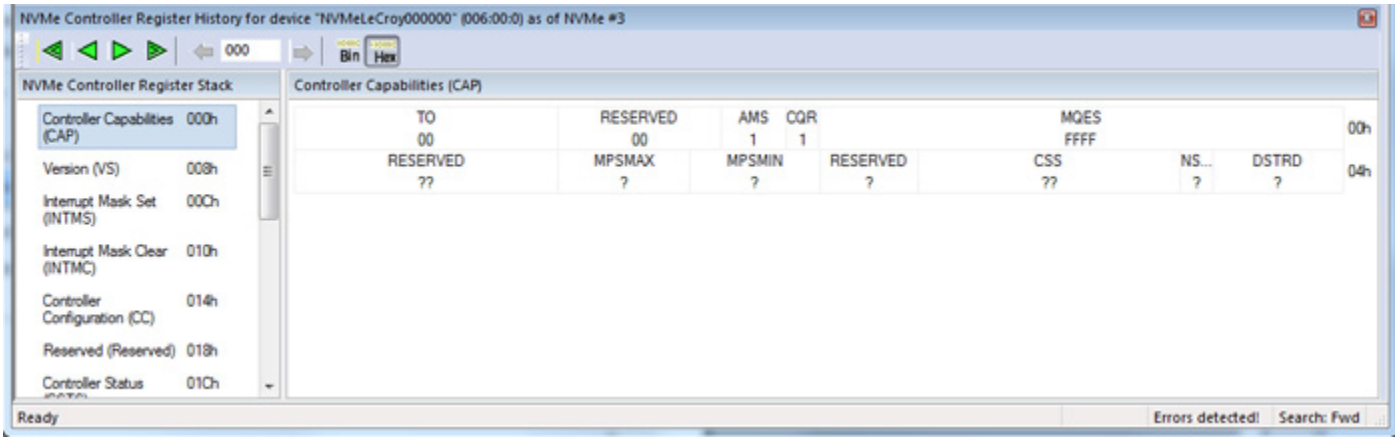


Figure 6.65: NVMe Controller Registers: Controller Capabilities (CAP) 000h Displayed

6. As an example you could click on the Next NVMe arrow and the Admin Queue Attributes would be displayed (see Figure 6.66).

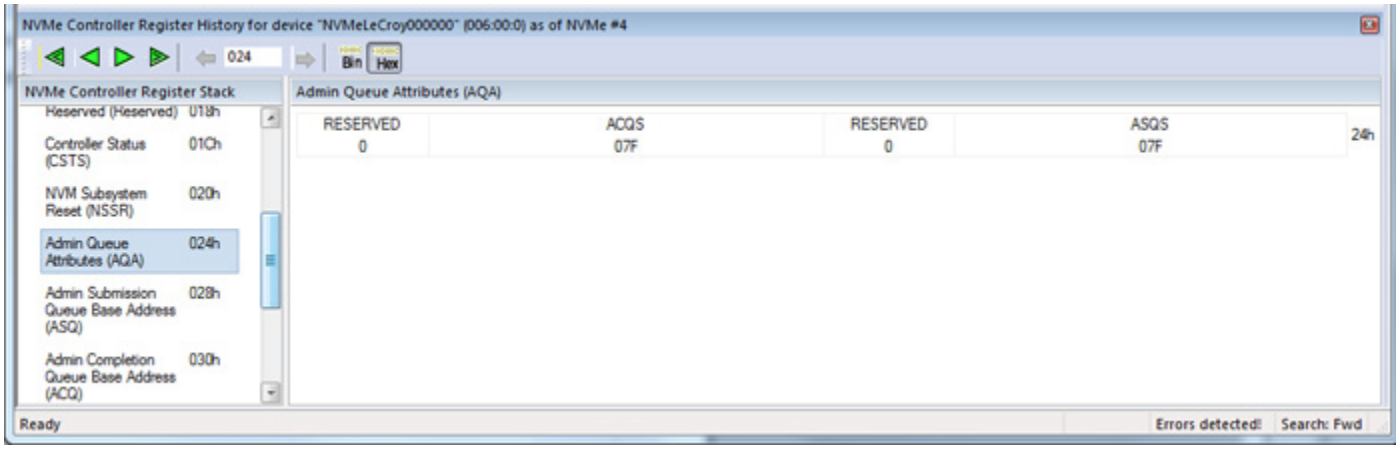


Figure 6.66: NVMe Controller Registers: Admin Queue Attributes (AQA) 024h Displayed

7. You can continue clicking the Green arrow to see more of the NVMe Controller Register Stack. See Figure 6.67.

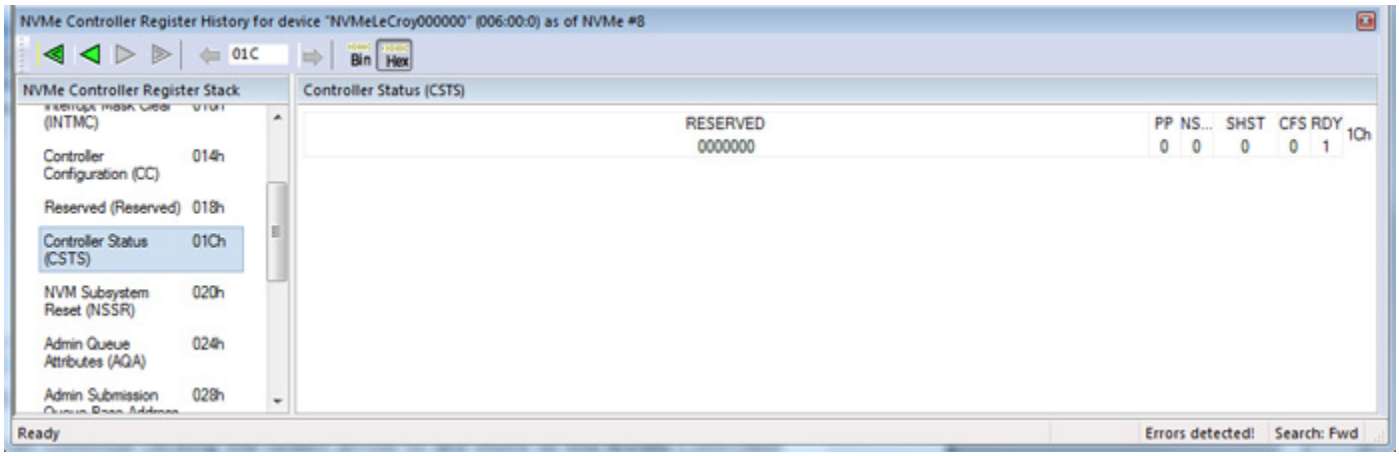


Figure 6.67: NVMe Controller Registers: Controller Status (CSTS) 01Ch

6.11.4.12 Decoding Multiple NVMe Commands for a Single MemRead or MemWrite

In some cases, a controller may fetch multiple NVMe commands in a single Memory Read or Write. At the NVMe Command level, the Analyzer software will decode this and show that there is an Implicit I/O Submission Queue Entry for that command and refer to the NVMe Transaction where the command was fetched from the Submission Queue. See Figure 6.68. NVMe transactions that are part of the current NVMe command are labeled as Explicit. In this case, the I/O Completion Queue contains NVMe transaction 311924 and it's labeled as an Explicit entry (also shown in Figure 6.68).

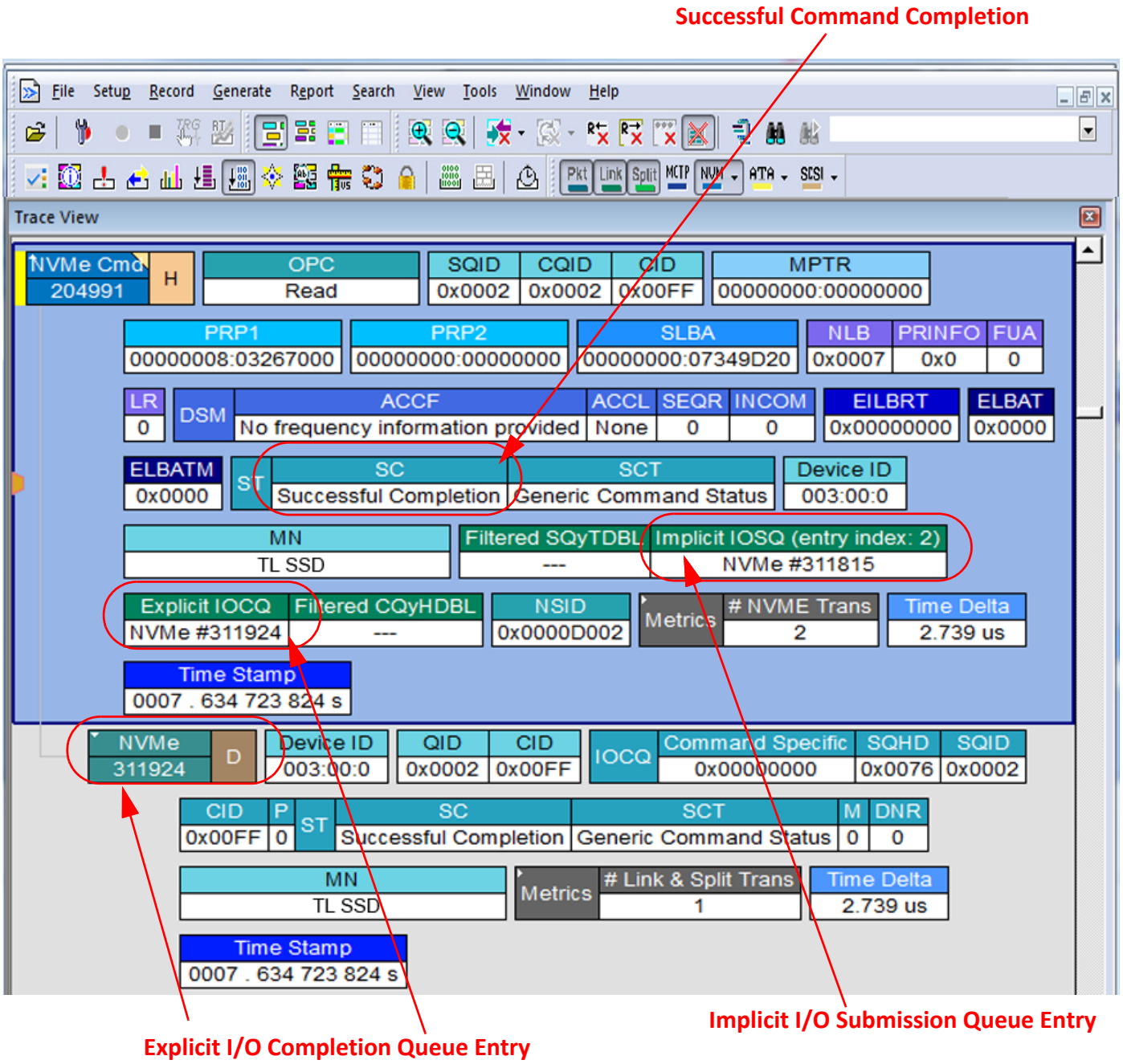


Figure 6.68: Implicit I/O Submission Queue Entry (IOSQ) and Explicit I/O Completion Queue Entry (IOCQ)

NVMe Transactions Decoded for NVMe Read Command:

- Implicit IOSQ: NVMe Transaction #311815 (entry index: 2)
- Explicit IOCQ: NVMe Transaction #311924 (part of this NVMe command: 204991)

The Implicit NVMe transaction (referenced by the Implicit label vs. Explicit label) can be found by right clicking on the NVMe transaction number in the trace display (see Figure 6.69).

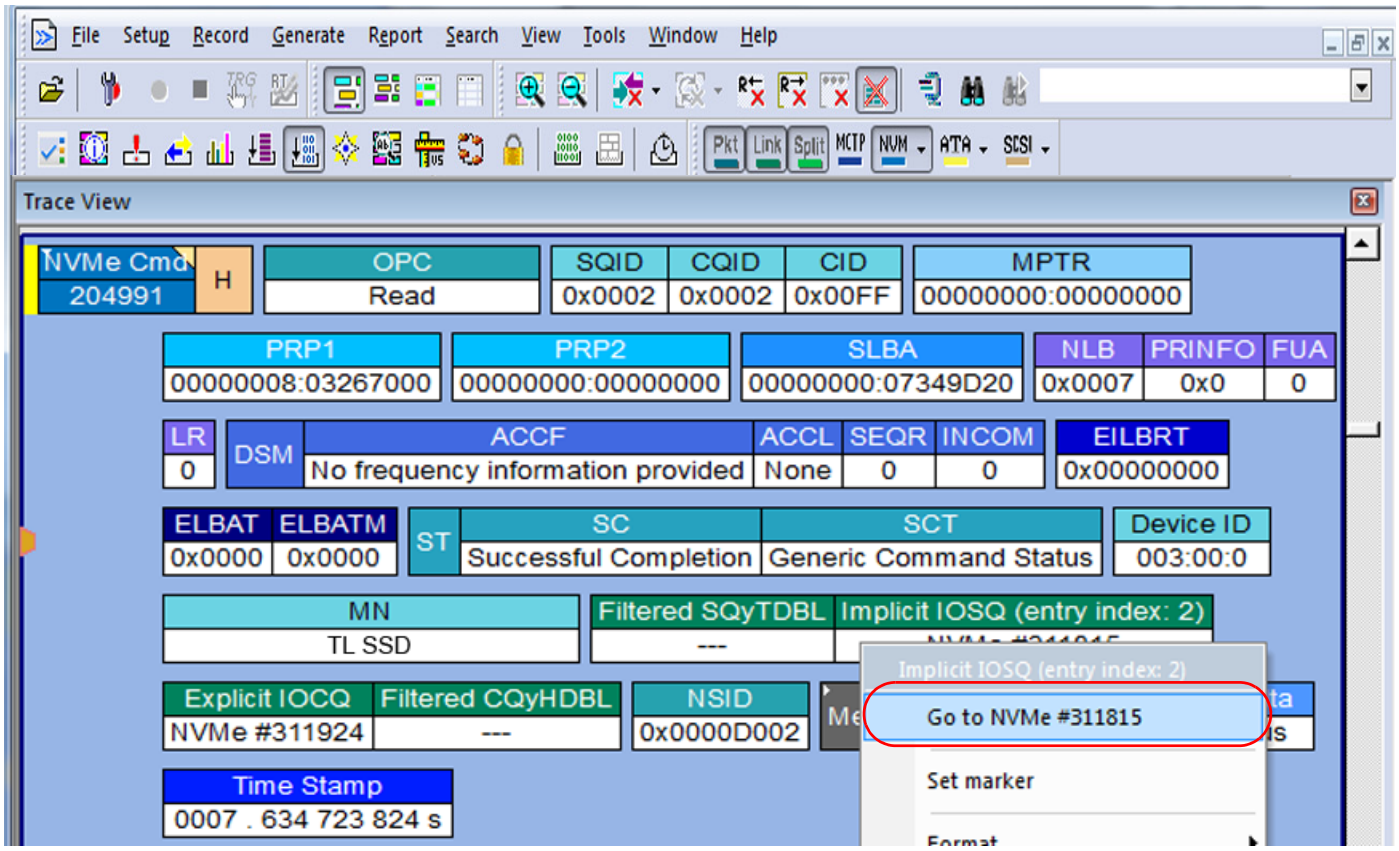


Figure 6.69: Implicit IOSQ Command

The display will be updated to that NVMe Transaction Number (and show the NVMe Command that it's a part of. In this case the Implicit NVMe Transaction (311815) is part of NVMe Command Number 204918. See Figure 6.70 on page 434)

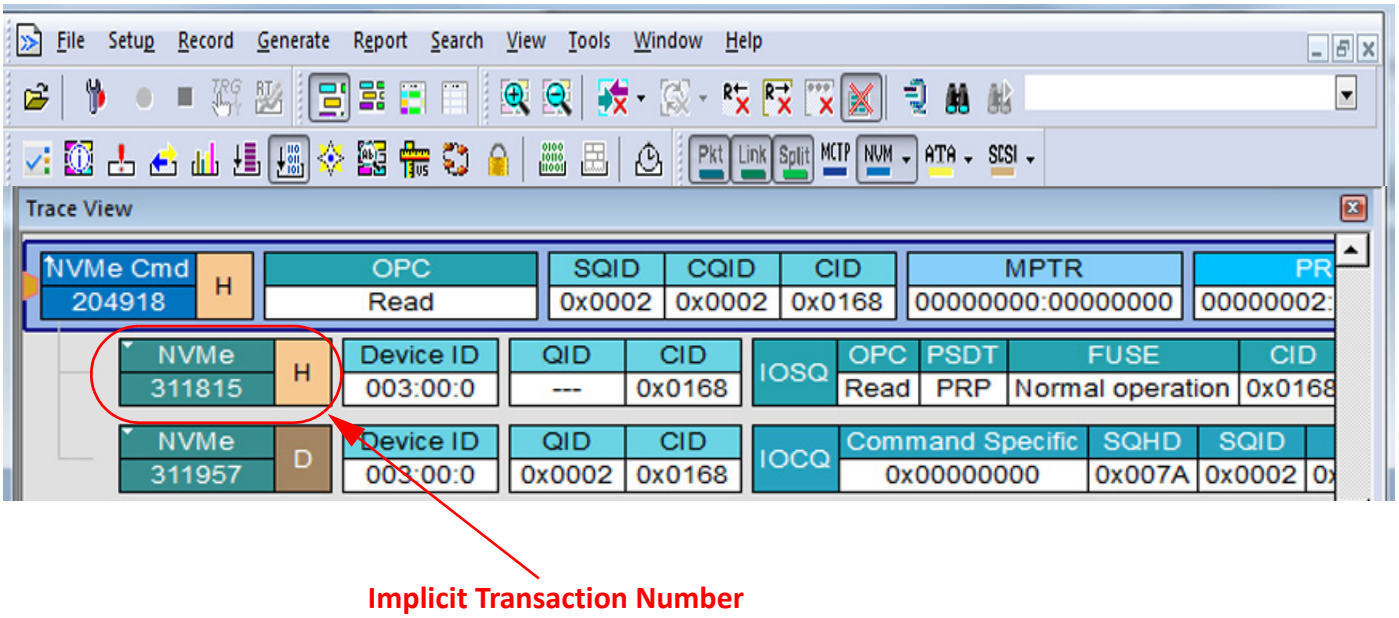


Figure 6.70: NVMe Transaction #318815: Part of NVMe Command 204918

If you expand the NVMe Transaction 311815 down to the Packet level (312224), you'll see two commands (32 DWORDS). See Figure 6.71.

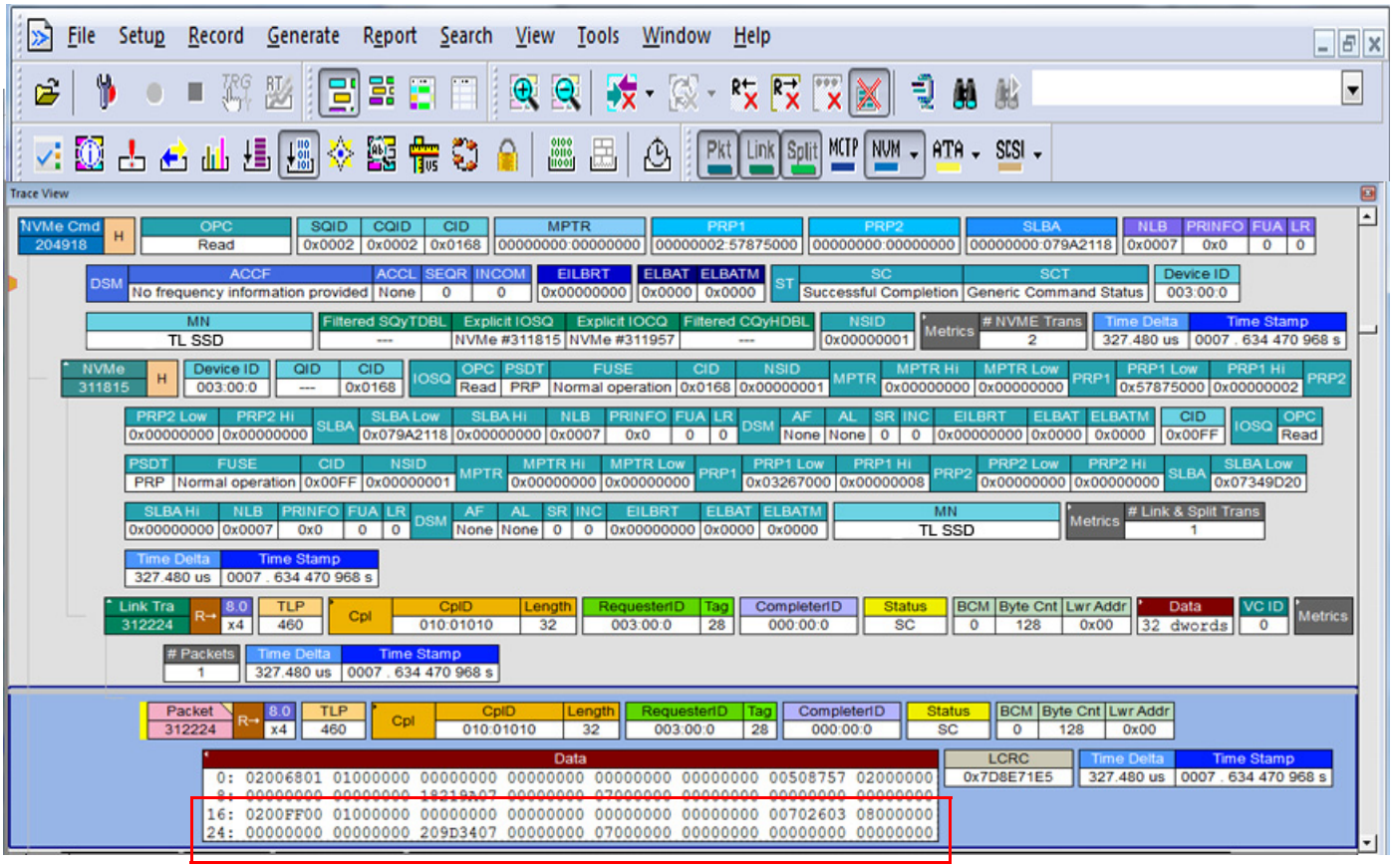


Figure 6.71: Implicit NVMe Transaction Decoded to Packet Level with Two Commands

6.11.5 NVMe 1.2 Specification Decoding

The PCIe Protocol Analysis has several enhancements to decode the NVMe 1.2 Specification (as seen in the following figures: Figure 6.72, Figure 6.73, Figure 6.74 on page 437 and Figure 6.75 on page 438).

- Name Space Management
- Replay Protected Memory Blocks
- SSD Dialog Shared NameSpace
- SSD Dialog Version and CMB Configurations

The figure below (Figure 6.72) shows the support added for decoding of the namespace management commands in NVMe data traffic.

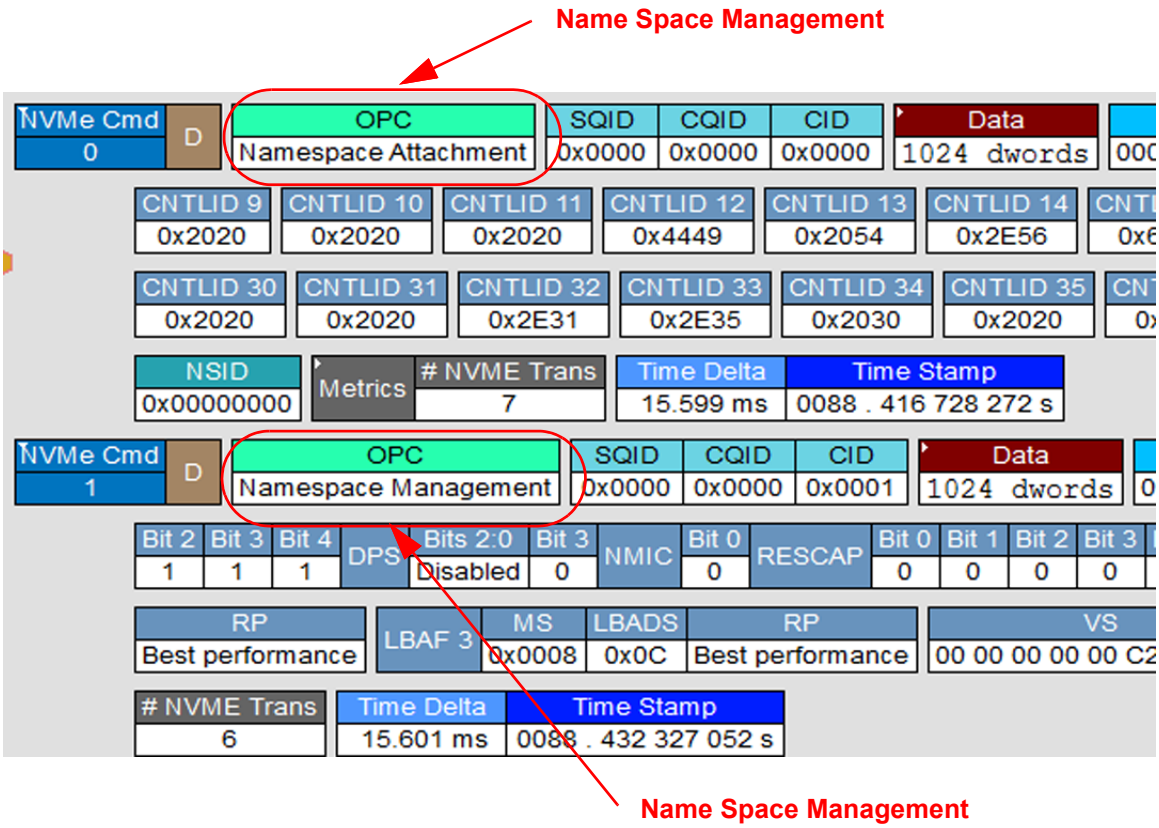


Figure 6.72: NVMe 1.2 Specification: Name Space Management

The Namespace Management command is used to create a namespace or delete a namespace. The Namespace Attachment command is used to attach and detach controllers from a namespace. Namespace management is intended for use during manufacturing or by a system administrator.

When a namespace is detached from a controller or deleted it becomes an inactive namespace on that controller. Previously submitted but uncompleted or subsequently submitted commands to the affected namespace are handled by the controller as if they were issued to an inactive namespace.

The figure below (Figure 6.73) shows the support added for the Replay Protected Memory Block (RPMB) command in NVMe data traffic.

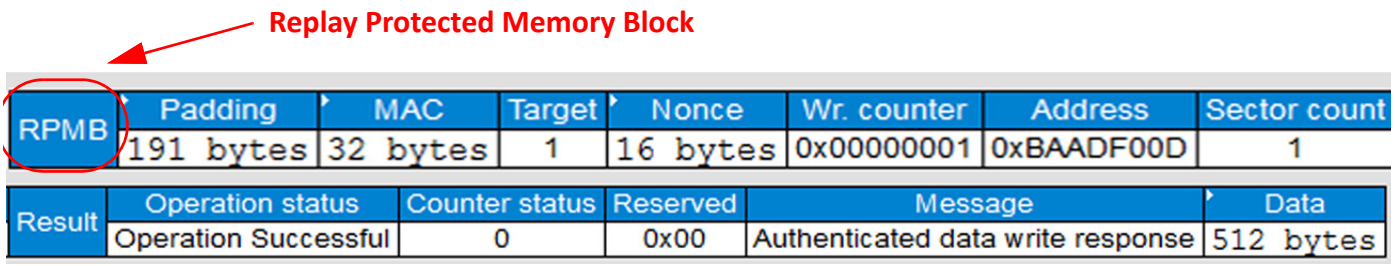


Figure 6.73: NVMe 1.2 Specification: Replay Protected Memory Block

The Replay Protected Memory Block (RPMB) provides a means for the system to store data to a specific memory area in an authenticated and replay protected manner. This is provided by first programming authentication key information to the controller that is used as a shared secret. The system is not authenticated in this phase, therefore the authentication key programming should be done in a secure environment (e.g., as part of the manufacturing process). The authentication key is utilized to sign the read and write accesses made to the replay protected memory area with a Message Authentication Code (MAC). Use of random number (nonce) generation and a write count register provide additional protection against replay of messages where messages could be recorded and played back later by an attacker.

The figure below (Figure 6.74) shows the support added for the Shared Namespace command in NVMe data traffic.

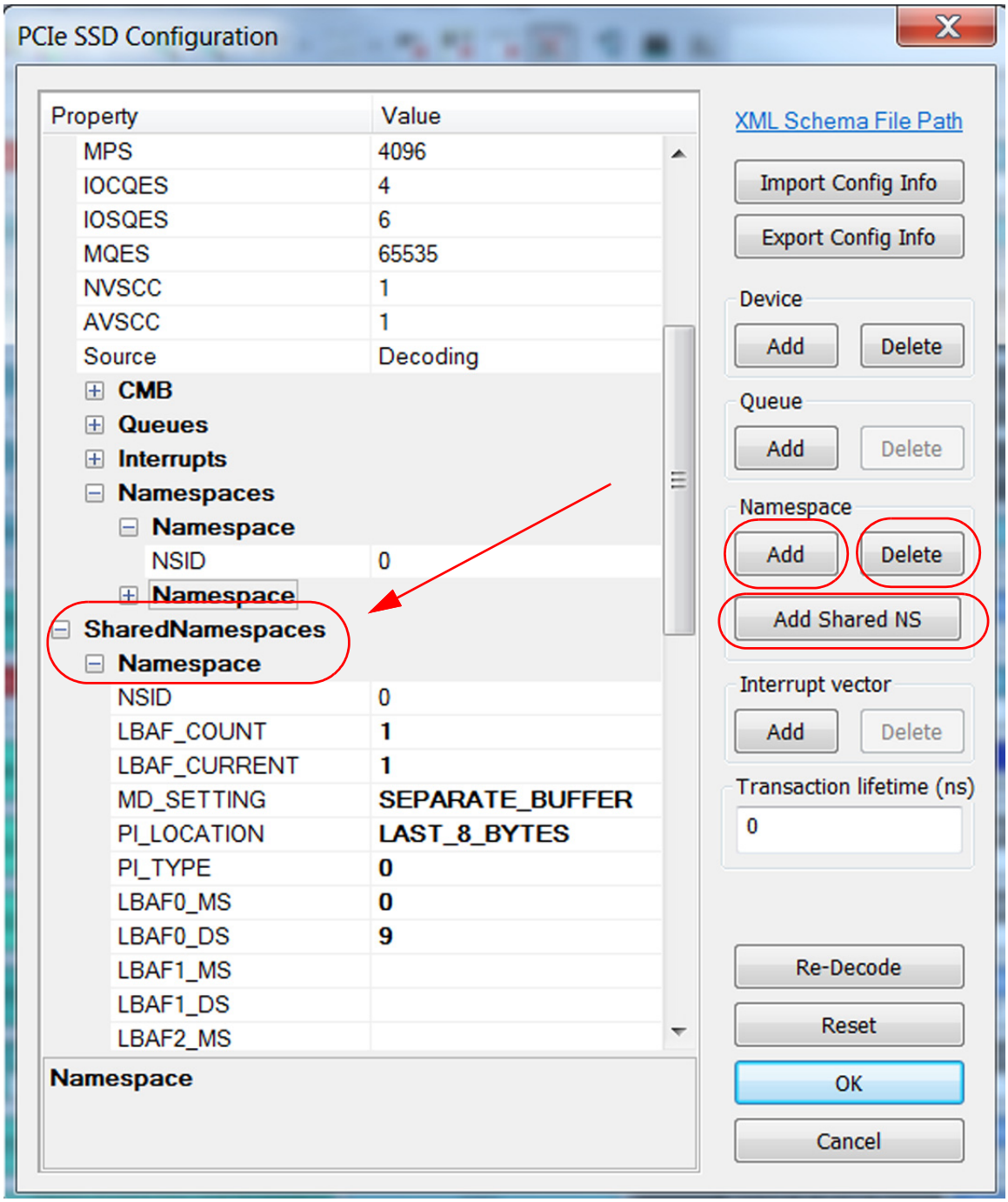


Figure 6.74: NVMe 1.2 Specification: Shared Namespaces

You can “Add” or “Delete” a namespace or Add a Shared namespace. A shared namespace is defined as a namespace that is accessible by two or more controllers in an NVM subsystem. A host may determine whether a namespace is a private namespace or may be a shared namespace by the value of the Namespace Multi-path I/O and Namespace Sharing Capabilities (NMIC) field in the Identify Namespace data structure.

The figure below (Figure 6.75) shows the added support for the Controller Memory Buffer (CMB) as defined in the NVMe 1.2 Spec.

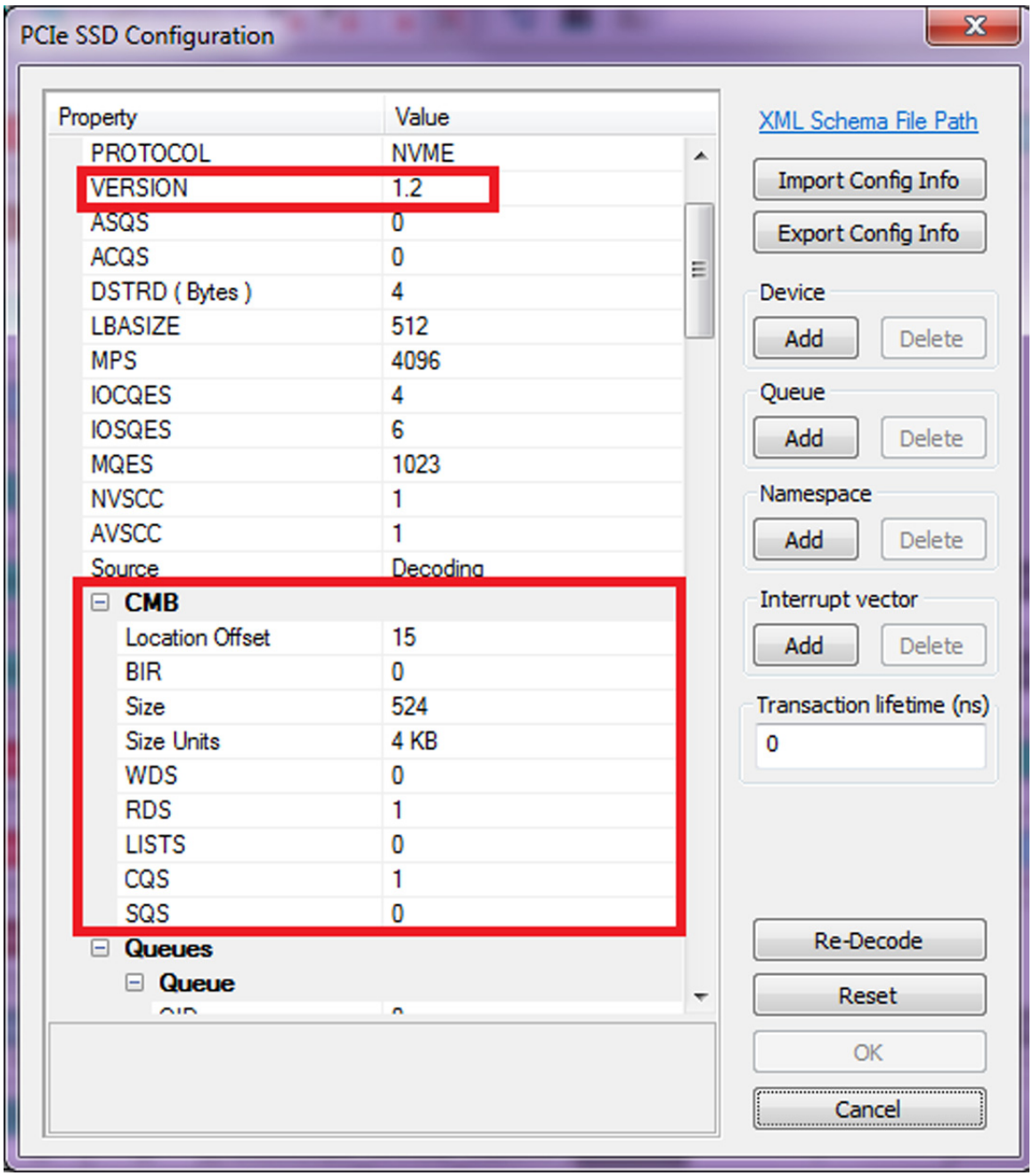


Figure 6.75: NVMe 1.2 Specification: SSD Dialog Version and CMB Configuration

The Controller Memory Buffer (CMB) is a region of general purpose read/write memory on the controller that may be used for a variety of purposes. The controller indicates which purposes the memory may be used for by setting support flags in the CMBSZ register.

6.11.6 Support for Physical Region Page (PRP) and Scatter Gather List (SGL) in Controller Memory Buffer (CMB)

The PCIe Protocol Analysis software supports PRP and SGL in CMB. See Figure 6.76 through Figure 6.78 on page 441.

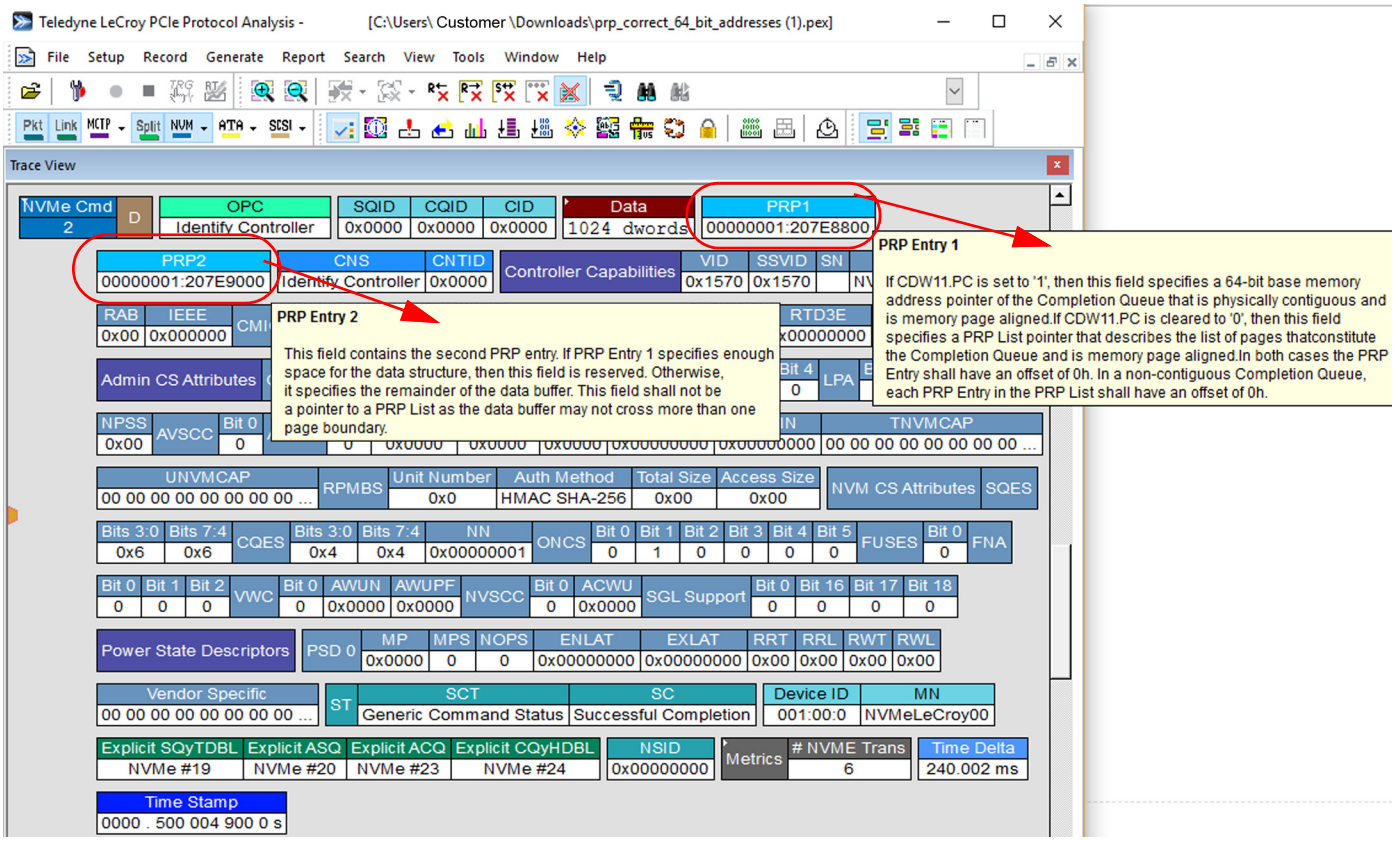


Figure 6.76: PRP1 and PRP2 in CMB Supported in PCIe Protocol Analysis Software

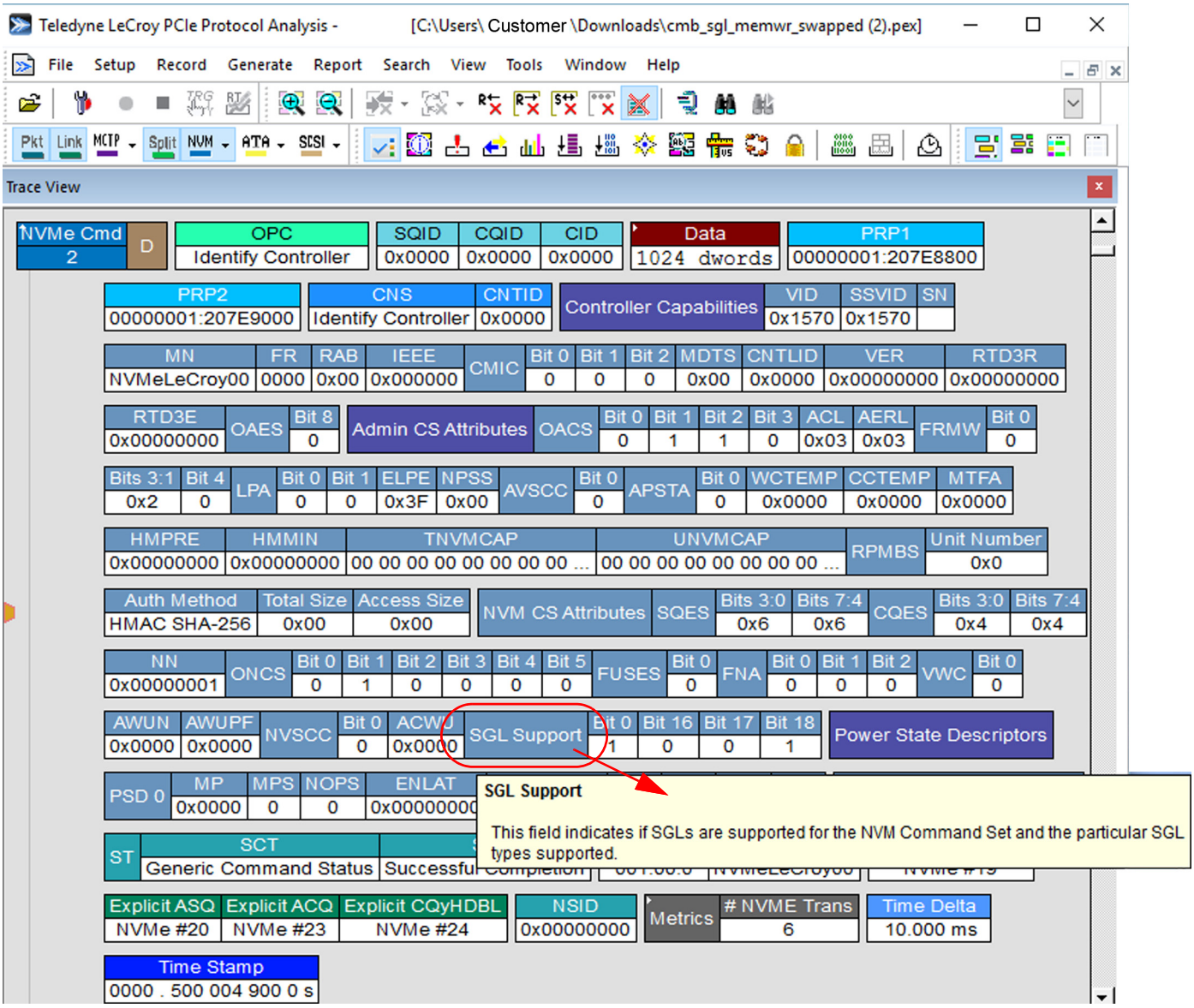


Figure 6.77: SGL Descriptor Supported in PCIe Protocol Analysis Software

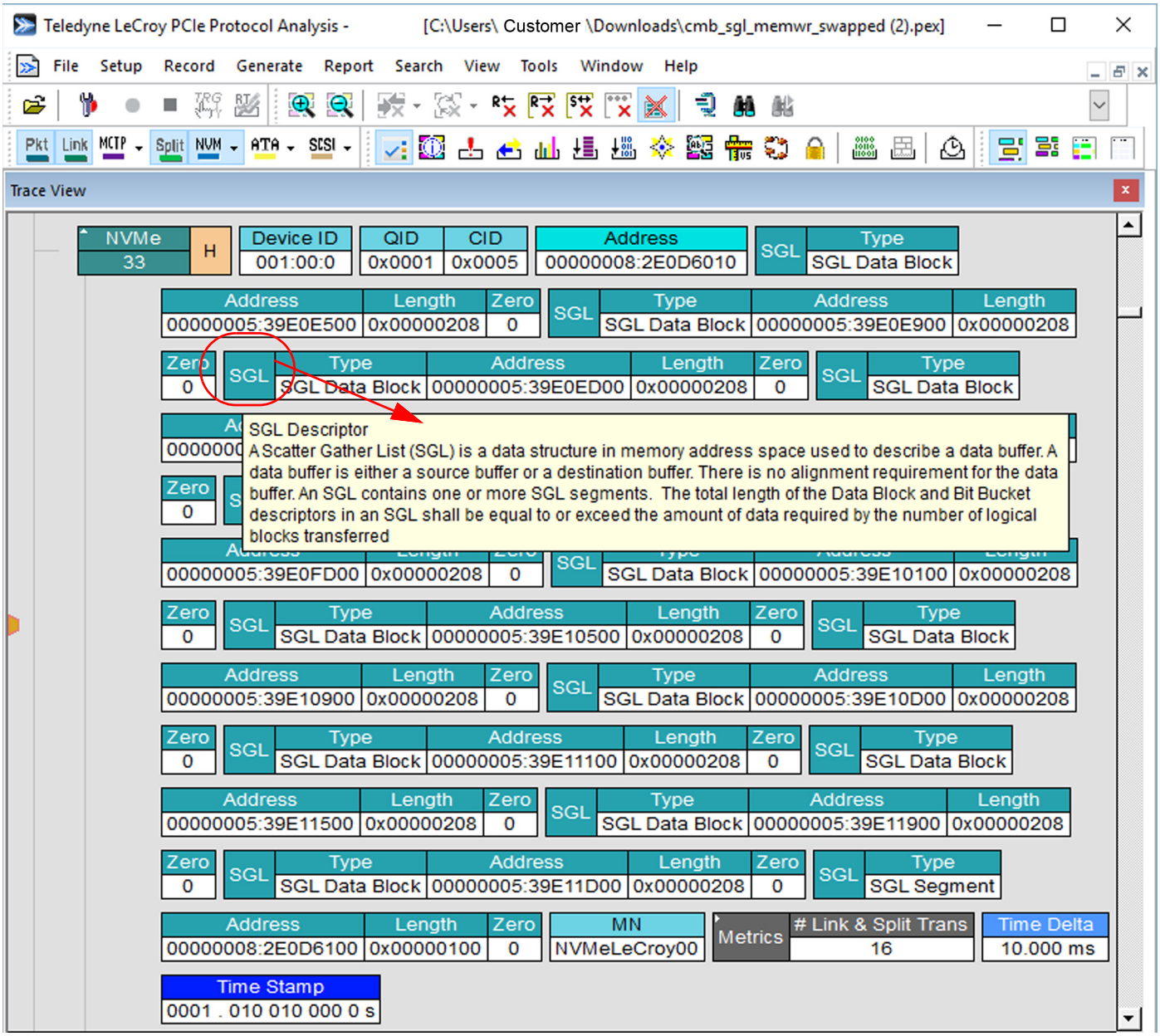


Figure 6.78: SGL Descriptor Tooltip

6.11.7 NVMe Decoding for Host Memory Buffer FID

The PCIe Protocol Analysis software can decode NVMe Host Memory Buffer FID as shown in Figure 6.79.

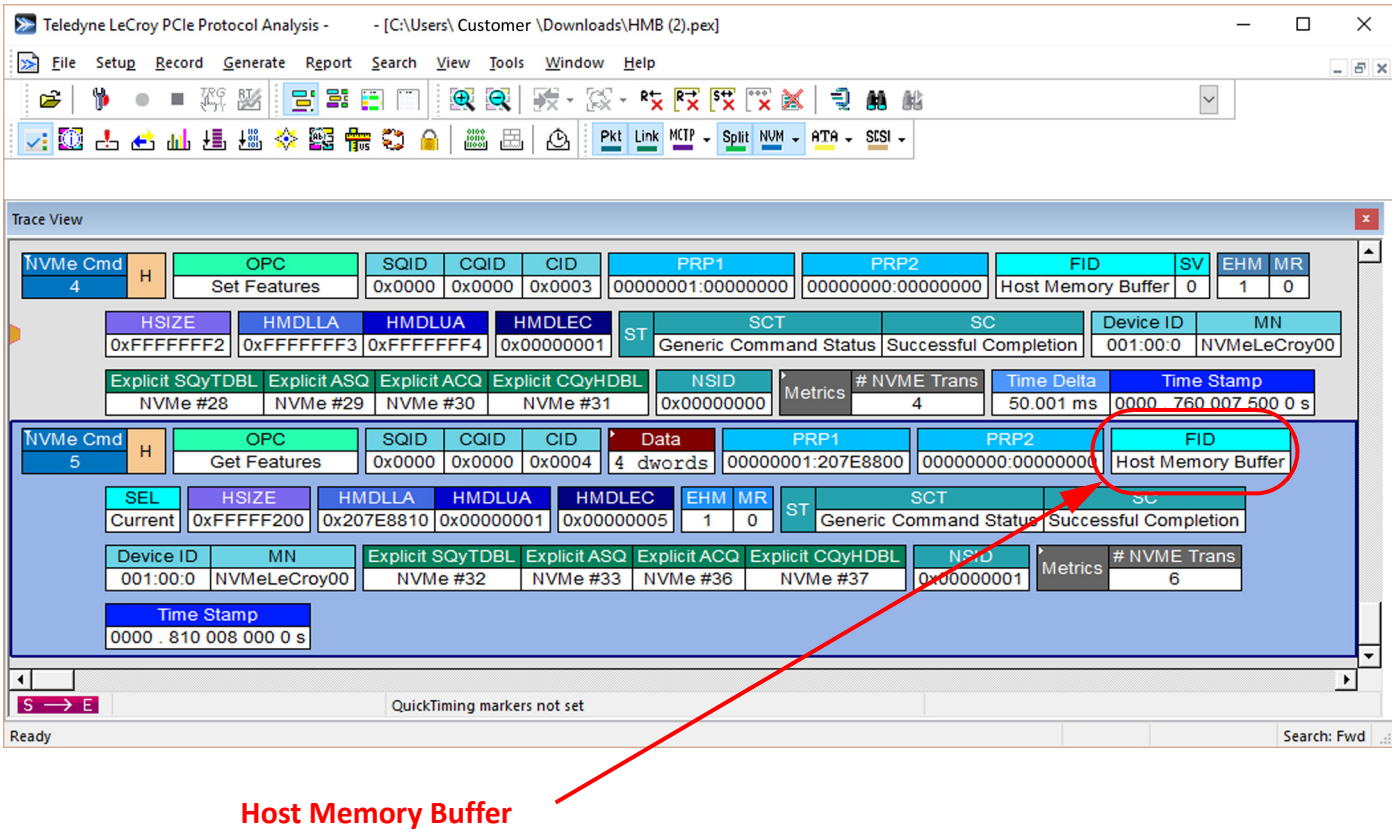
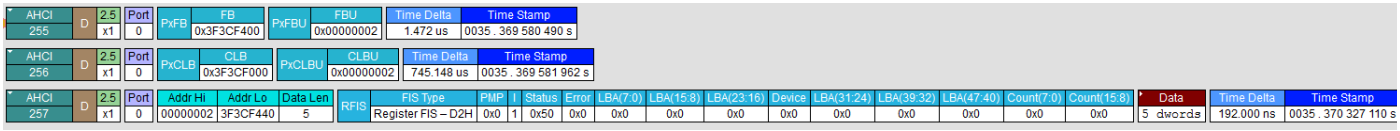


Figure 6.79: NVMe Trace with Host Memory Buffer FID Properly Decoded

6.11.8 AHCI

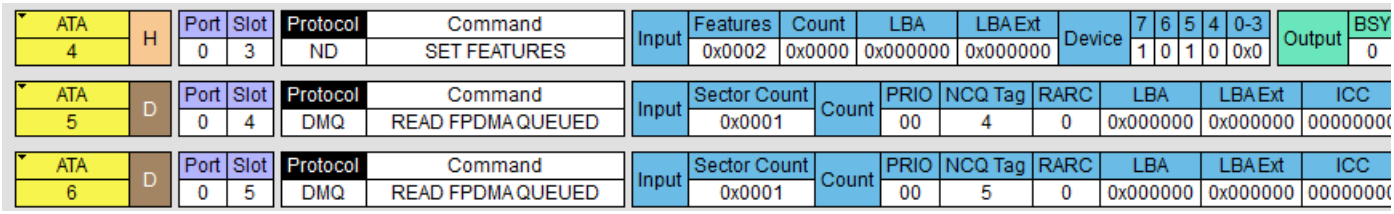
AHCI level decode displays AHCI transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of AHCI, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level and finally the AHCI decode level.



Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and AHCI transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

6.11.9 ATA

ATA level decode displays ATA transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of ATA, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level, then AHCI level and finally the ATA decode level.



Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and ATA transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

6.11.9.1 ATA IO: Pending Transactions Statistical Report

ATA IO Pending Transactions statistical information can be displayed from an ATA Trace by selecting an ATA Packet and viewing the Metrics box. See Figure 6.80.

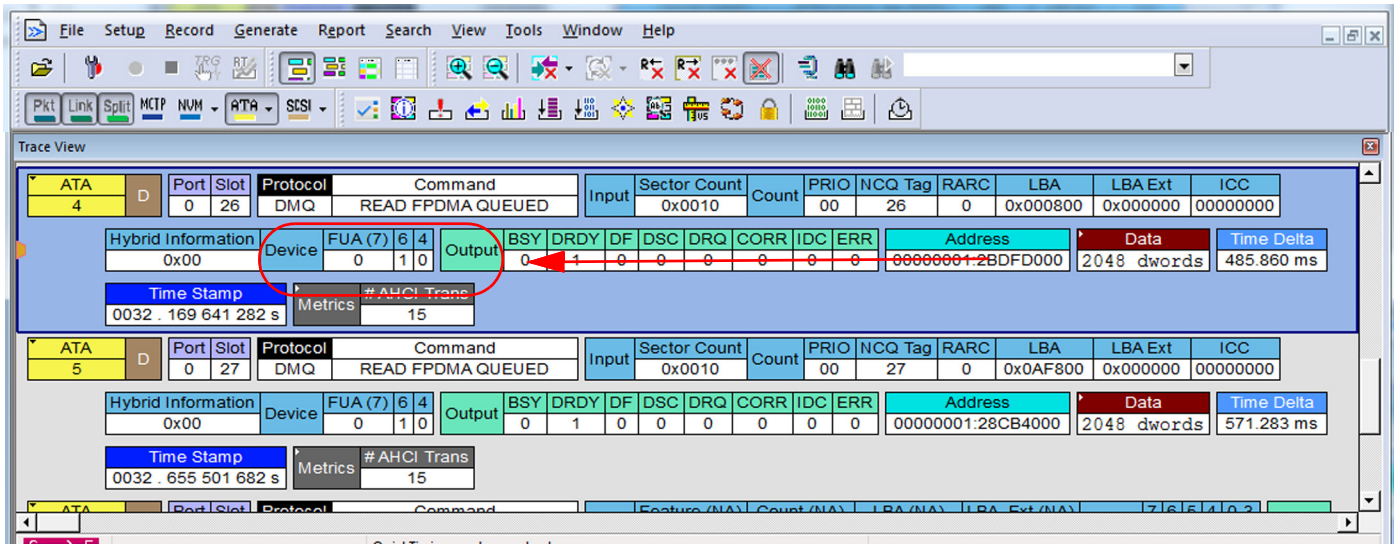


Figure 6.80: ATA IO Pending Transactions: Metrics Box

Move the cursor over the Metrics box to display the information about the ATA Packet. See Figure 6.81 on page 444.

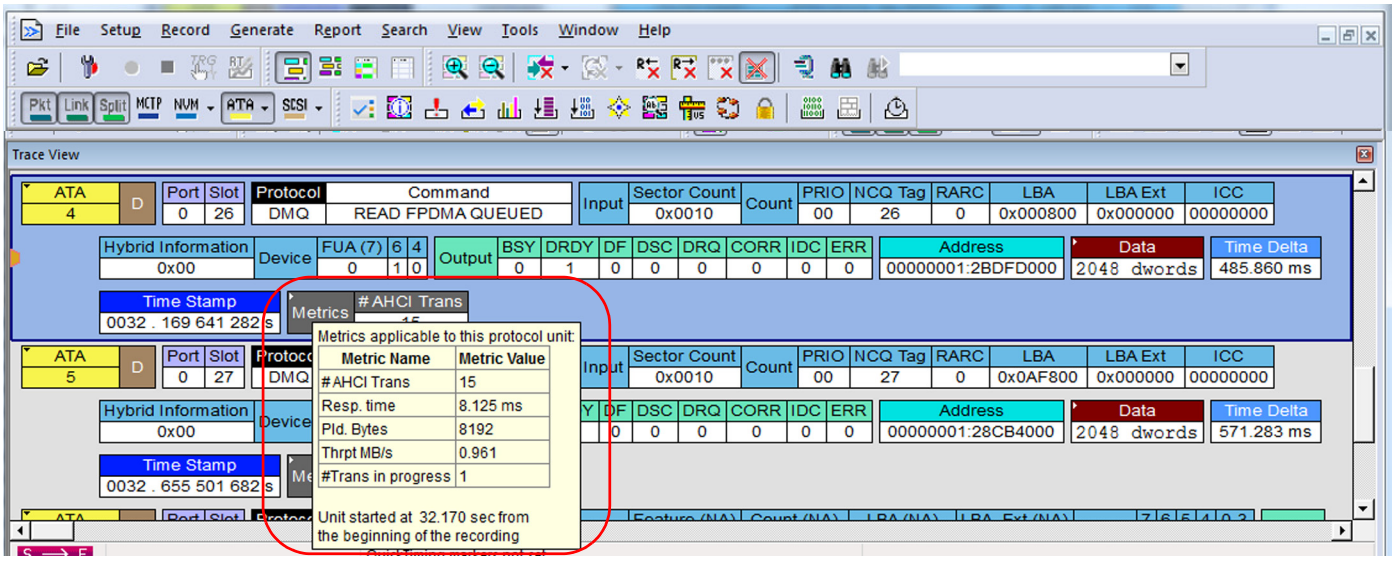


Figure 6.81: ATA IO Pending Transactions: Metrics Box -- Information Displayed

You can click on the small white arrow in the Metrics box to display the information in the Trace. See Figure 6.82.

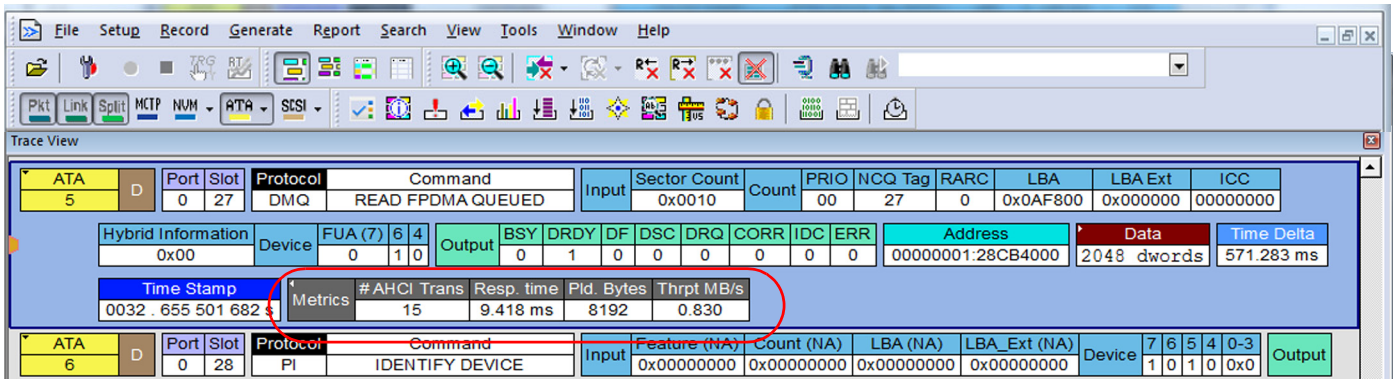


Figure 6.82: ATA IO Pending Transactions: Metrics Displayed in Trace

You can also view the ATA IO Pending Transactions by selecting the Bus Utilization icon in the toolbar and selecting the Graph Areas icon. See Figure 6.83 on page 446.

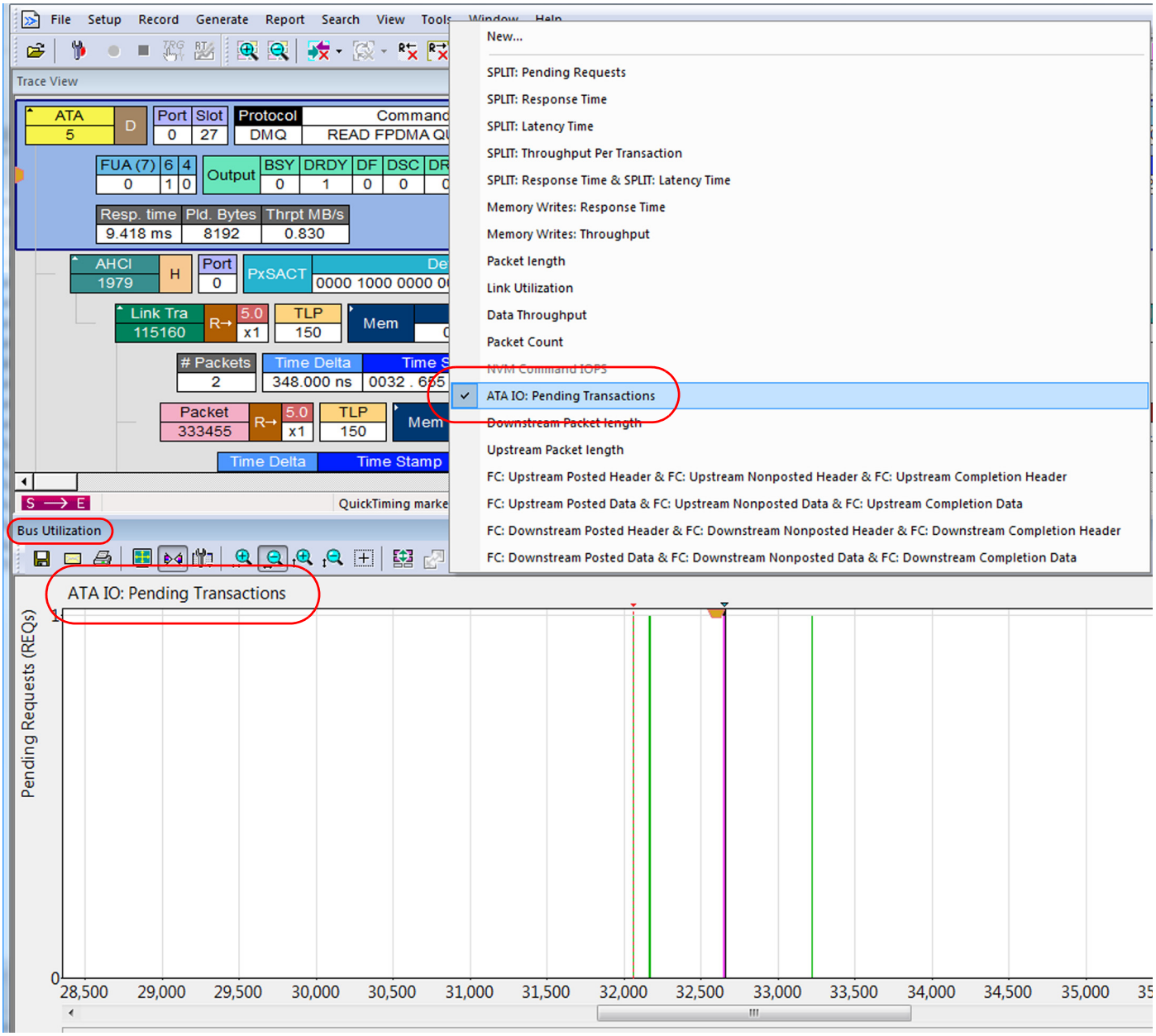
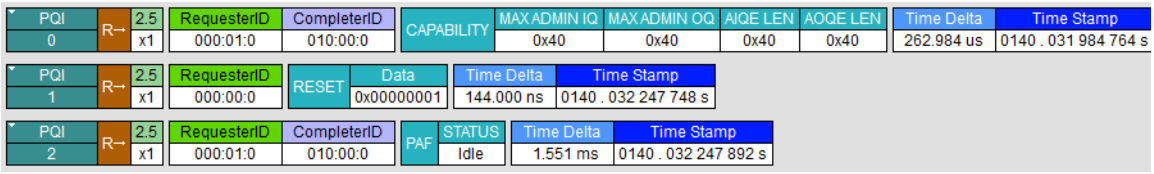


Figure 6.83: ATA IO Pending Transactions: Bus Utilization View

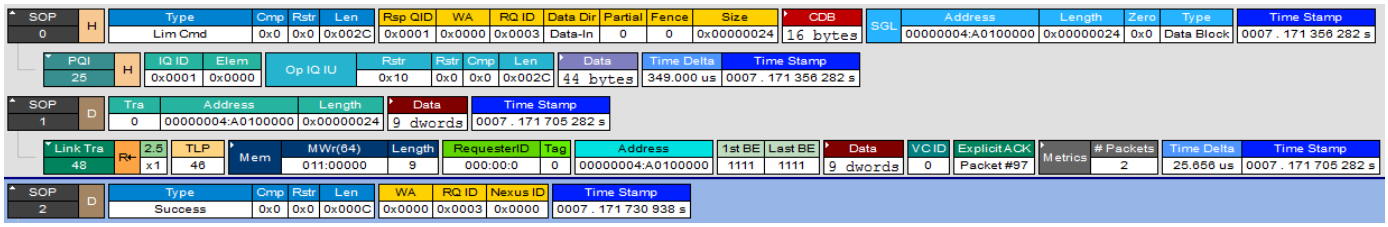
6.11.10 PQI

PQI level decode PQI displays PQI transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of PQI, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level and finally the PQI decode level.



6.11.11 SOP

SOP level decode SOP displays SOP transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of SOP, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level, then PQI level and finally the SOP decode level.



Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and SOP transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

6.11.12 SCSI

SCSI level decode SCSI displays SCSI transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of SCSI, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level, then PQI level and finally the SCSI decode level.



SCSI	SCSI CDB	OpCode	Obsolete	EVPD	Page Code	AllocLen	CONTROL	INQUIRY	LUN	Metrics	# SOP IUs	Time Stamp
0	INQUIRY	0x12	Not set	Not set	0x0	36	0x00	Response	0		3	0007 . 171 356 282 s

Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and SCSI transactions can be properly decoded. If the enumeration sequence is not available, the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

6.11.13 Decoding MCTP (Management Component Transport Protocol)

Note: The Summit T316, Summit T3-8 and Summit T34 can decode MCTP traffic per specifications outlined in the *Readme* file.

6.11.13.1 MCTP Levels in Floating Transactions Bar Window

To decode MCTP traffic you must first load a trace containing MCTP traffic. You can get a visual representation of the MCTP Command structure by pulling the Transaction Level Toolbar (see Figure 6.84) down into the trace and the Floating Transaction Level Bar Window will be shown (see Figure 6.85). The Transaction Level Window shows that the MCTP Command is made up of Links and Packets. You can also see that NVMe, ATA and SCSI traffic consists of Link and Split transactions.



Figure 6.84: Transaction Level Toolbar

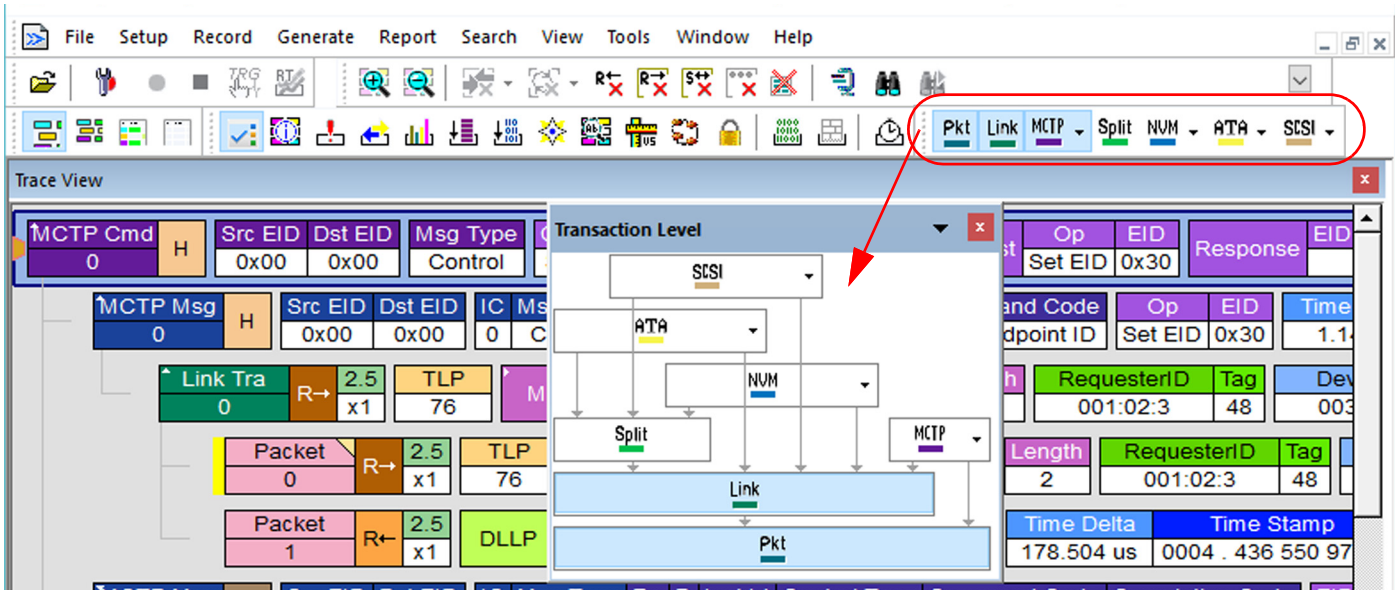


Figure 6.85: MCTP Levels in Floating Transaction Bar Window

6.11.13.2 Decoding MCTP Commands

MCTP traffic can be decoded and displayed as either MCTP Commands or MCTP Messages.

To decode MCTP traffic you must first load a trace containing MCTP traffic. Then click the MCTP icon on the toolbar and select MCTP Commands. See Figure 6.86.

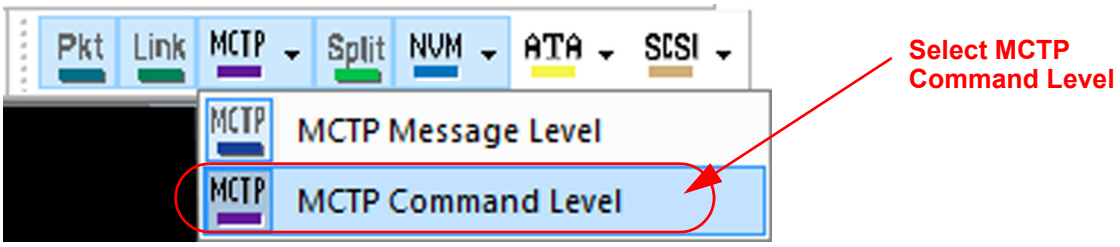


Figure 6.86: MCTP Decoding Icon on Toolbar

This will decode MCTP Commands in the trace. The following types of MCTP Message Types can be decoded:

- MCTP Control: See Figure 6.87 on page 451
- NC-SI: See Figure 6.87 on page 451
- PLDM: See Figure 6.88 on page 452
- PLDM: Firmware Commands Decoded -> See Figure 6.89 on page 452 and Figure 6.90 on page 453.
-

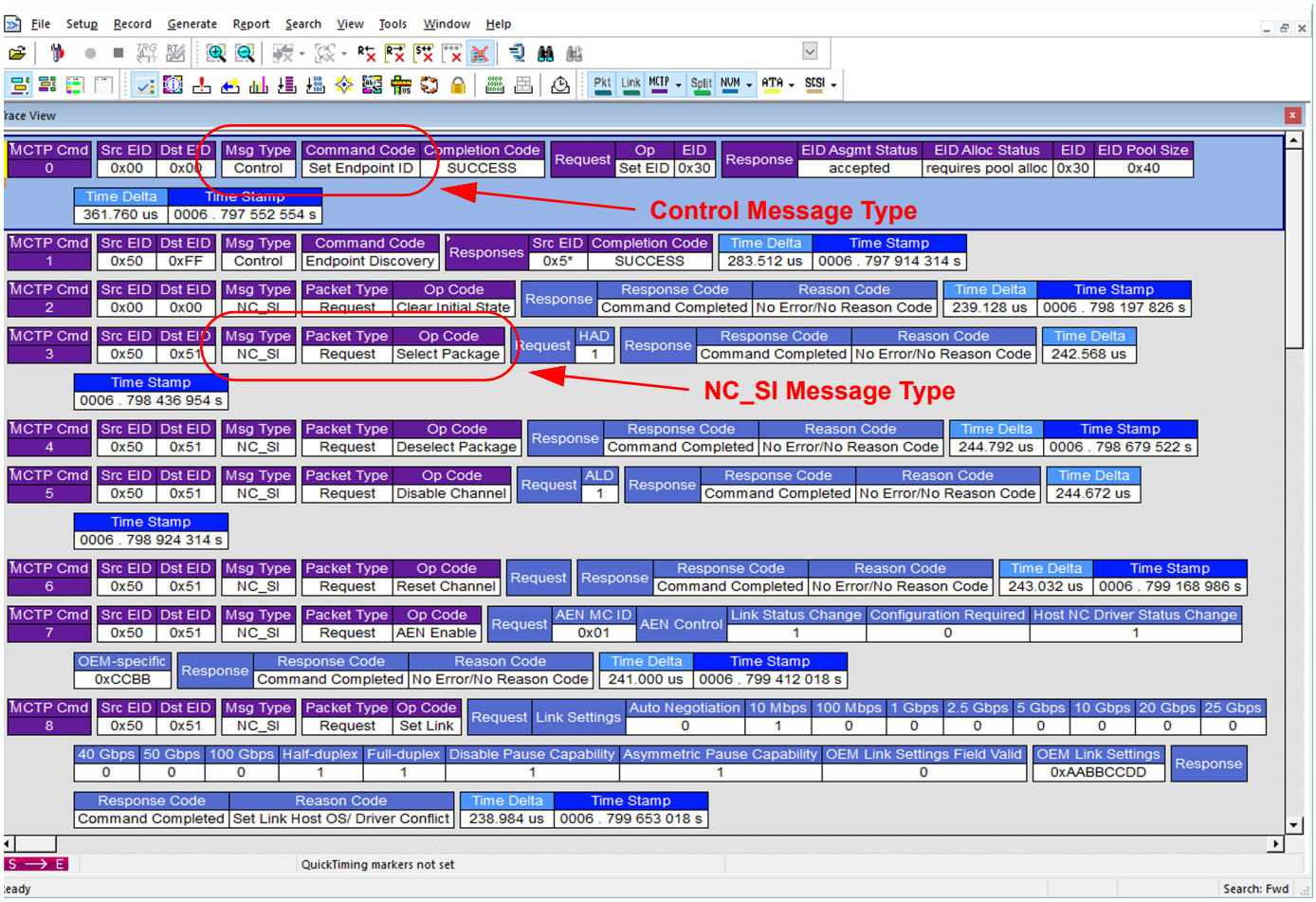


Figure 6.87: MCTP Commands Decoded: Control and NC_SI Types

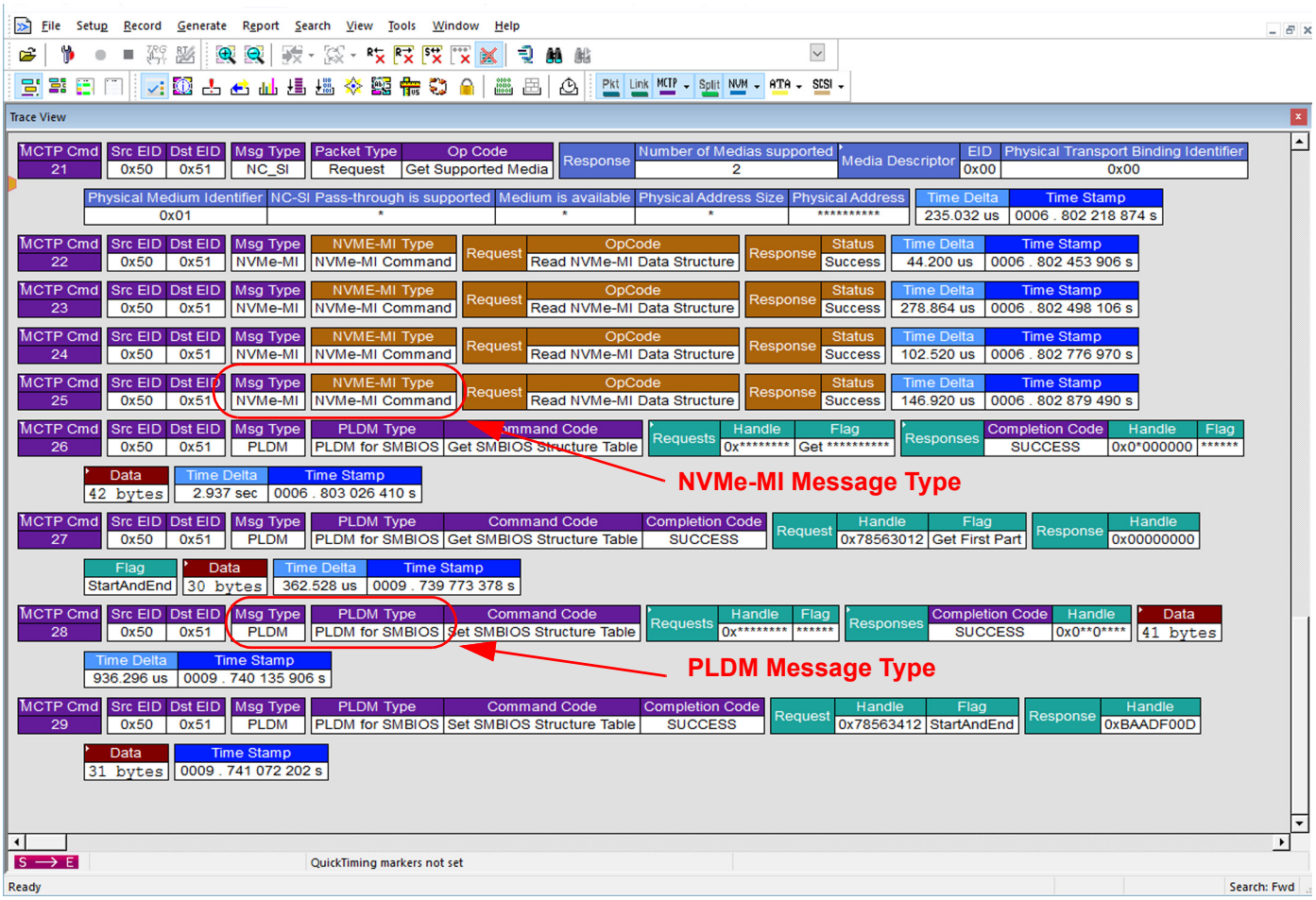


Figure 6.88: MCTP Commands Decoded: NVMe-MI and PLDM Types

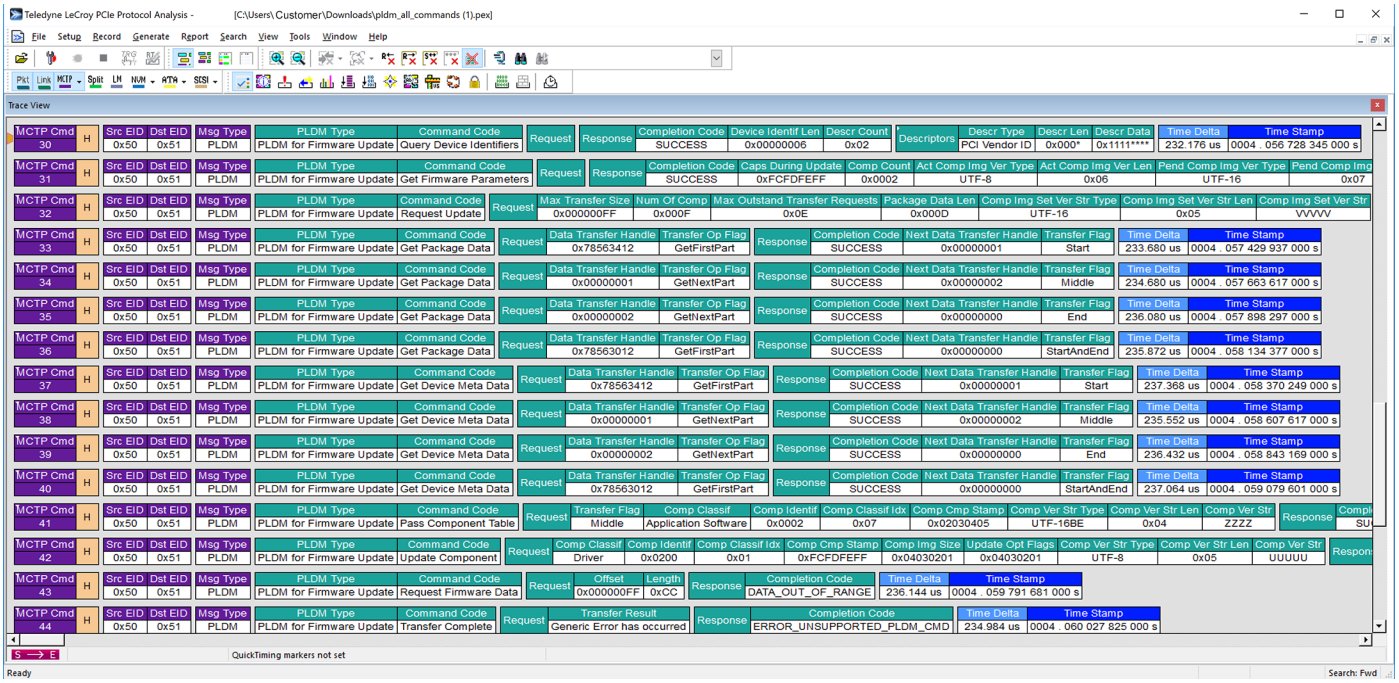


Figure 6.89: PLDM Firmware Update Commands Decoded

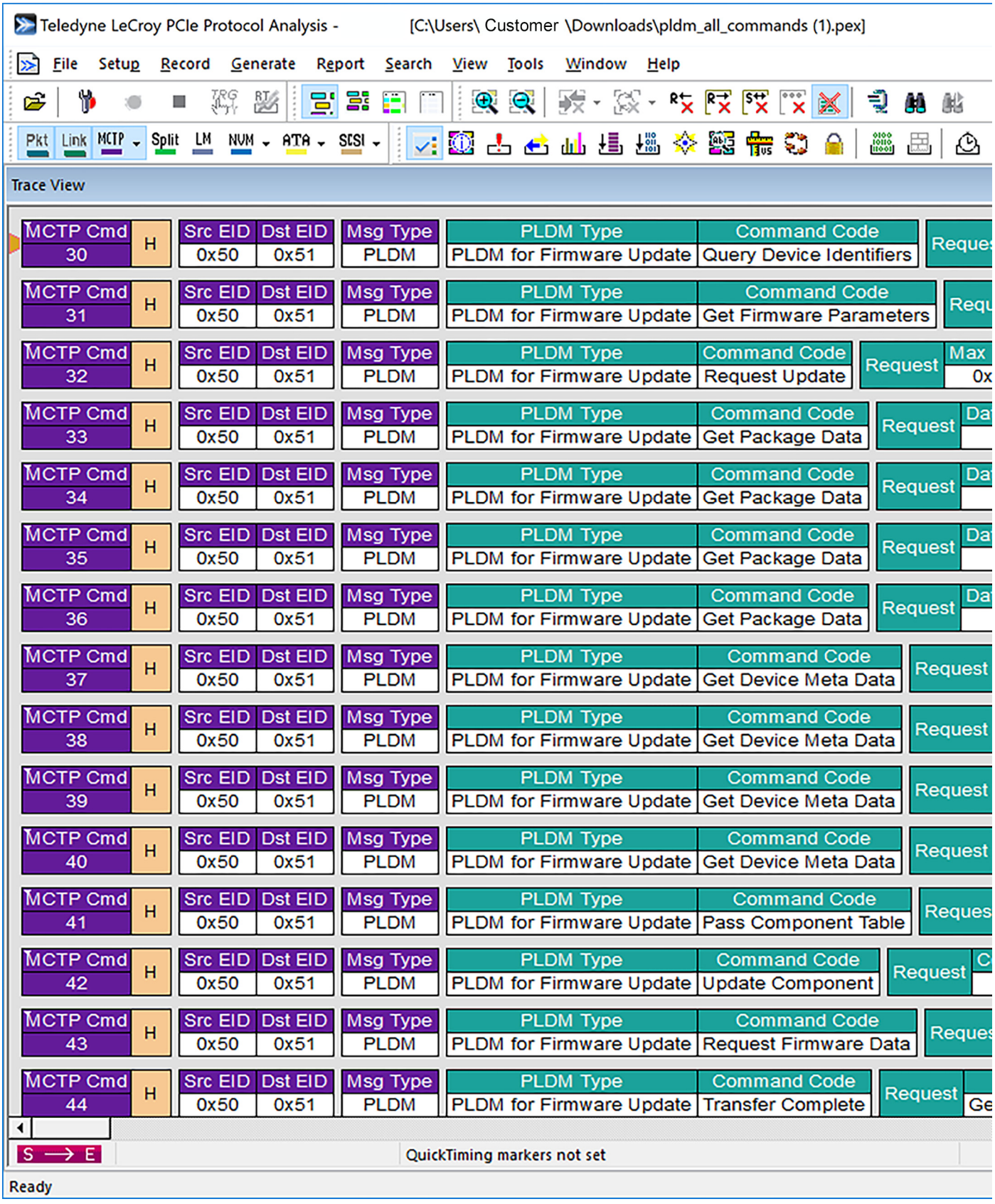


Figure 6.90: PLDM Firmware Update Commands Decoded (Details shown)

6.11.13.3 Expanding MCTP Commands

If you expand any MCTP command, you'll see all of the MCTP messages and lower level packets that make up the command. In this case we expanded MCTP Command 0. It consists of MCTP Message 0 from the Host and MCTP Message 1 from the Device. If you expand MCTP Message 0, you'll see that it consists of Link Transaction 0, which can be expanded down to Packet 0 and Packet 1. Notice that MCTP Command 0, MCTP Message 0, Link Transaction 0 and Packet 0 all have the same Timestamp: 0006.797.552.554 seconds. The response from the Device occurs as 0006.797.553.698 seconds. See Figure 6.91 on page 454.

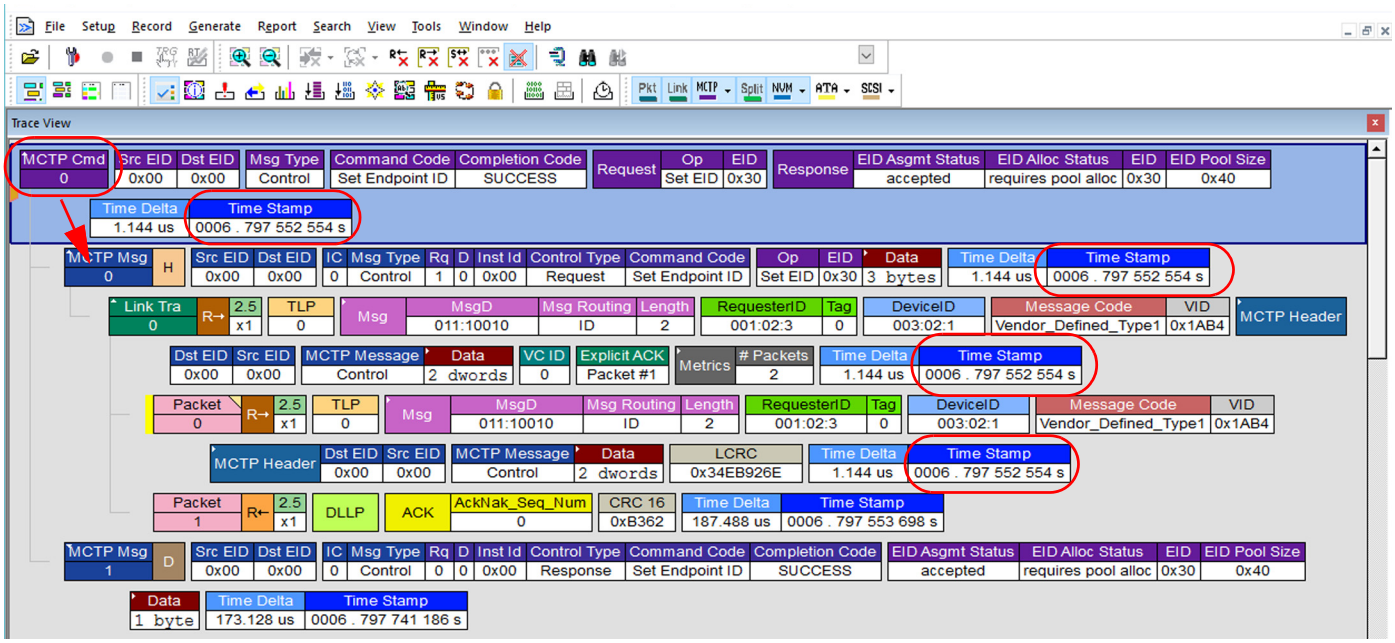


Figure 6.91: MCTP Command 0 Expanded

6.11.13.4 Decoding MCTP Messages

If you had selected MCTP Messages to be decoded instead of Commands, only the MCTP Messages would be displayed. See Figure 6.92.

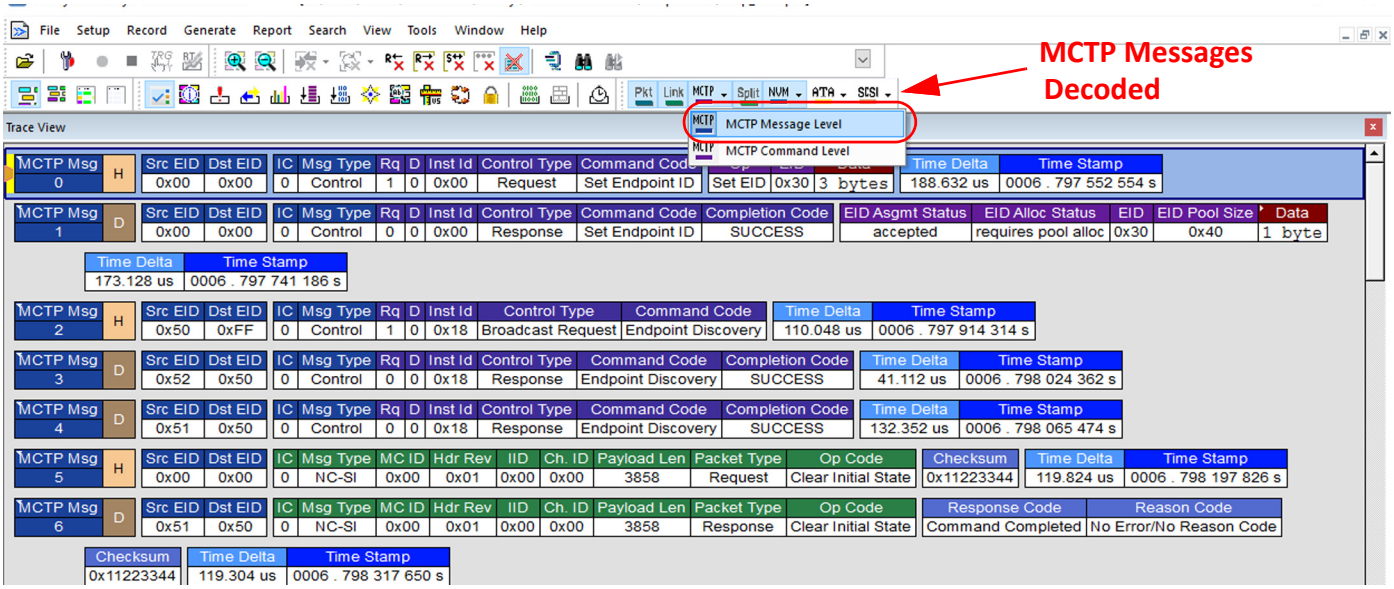


Figure 6.92: MCTP Messages Decoded

If you expand the MCTP Message you'll see the same information you saw by expanding the MCTP Command. See Figure 6.93 on page 455.

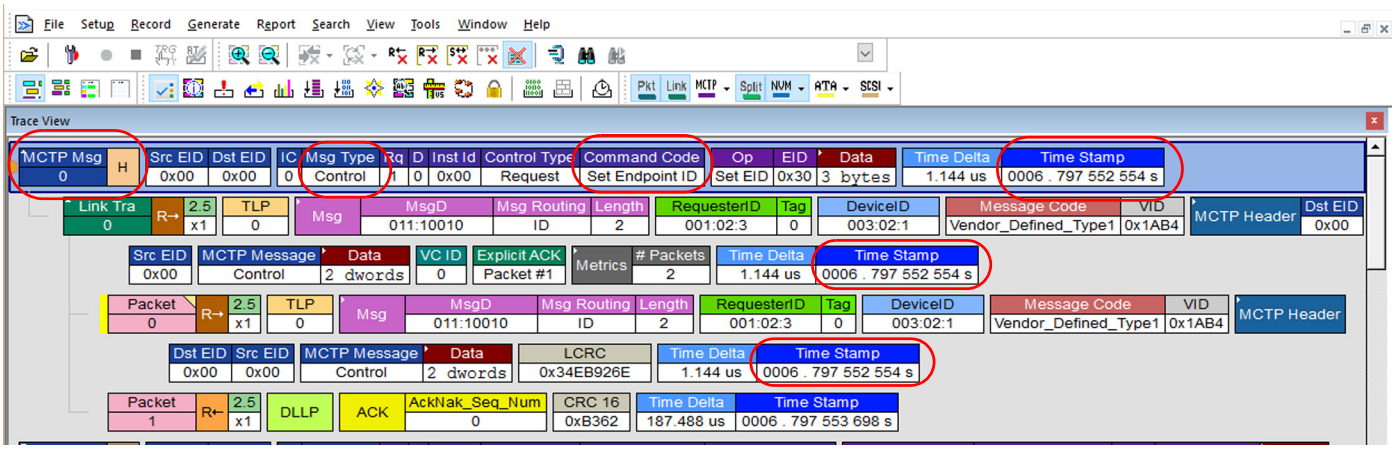


Figure 6.93: Expanding MCTP Message

6.11.13.5 MCTP Commands with SMBus Traffic

To decode an MCTP command with SMBus traffic you must first load a trace with the appropriate traffic. Then decode MCTP traffic by clicking on the MCTP icon in the toolbar. In the example shown below we've loaded a trace that has SMBus traffic within an MCTP message that is part of an MCTP command. See Figure 6.94.

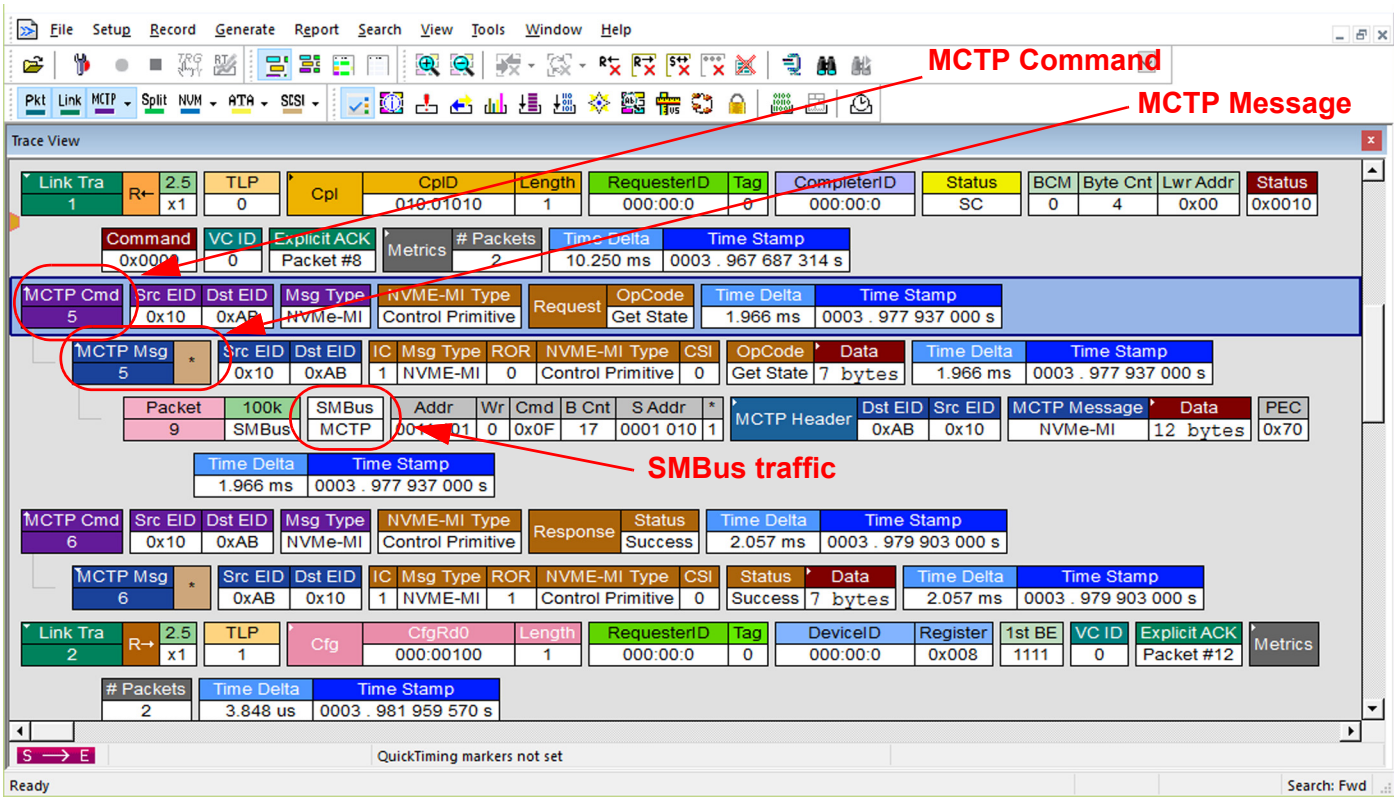


Figure 6.94: MCTP Command with SMBus Traffic

6.11.13.6 MCTP Commands: Request from Host, Response from Device

MCTP commands can be decoded as shown below (see Figure 6.95). As you can see the MCTP Command is made up of MCTP messages. One is from the Host the response is from the Device.

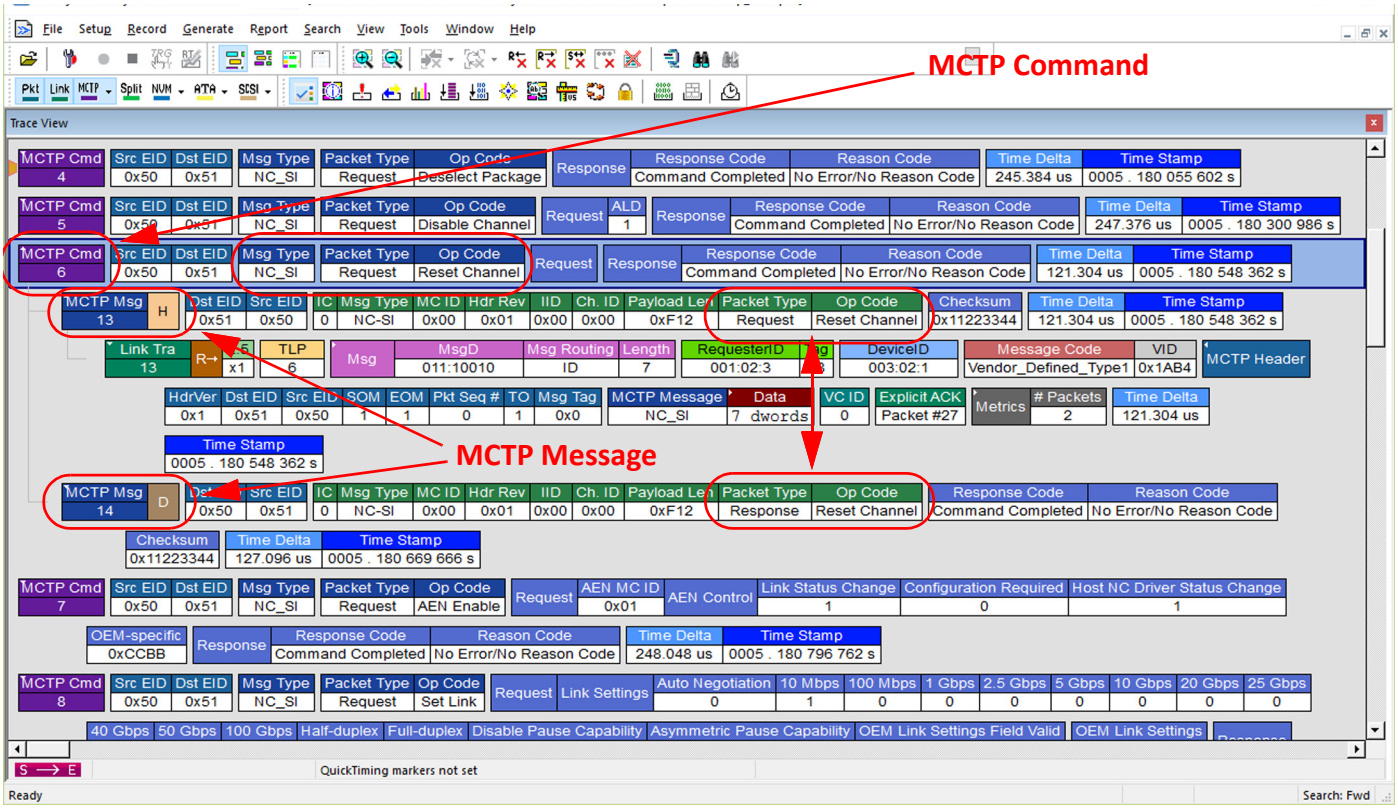


Figure 6.95: Decoding MCTP Commands

6.11.13.7 Decoding MCTP Messages and Transactions

Note: To decode MCTP messages and transactions you'll need a license for your analyzer. If you don't have a MCTP license a warning message will pop up. See Figure 6.96.

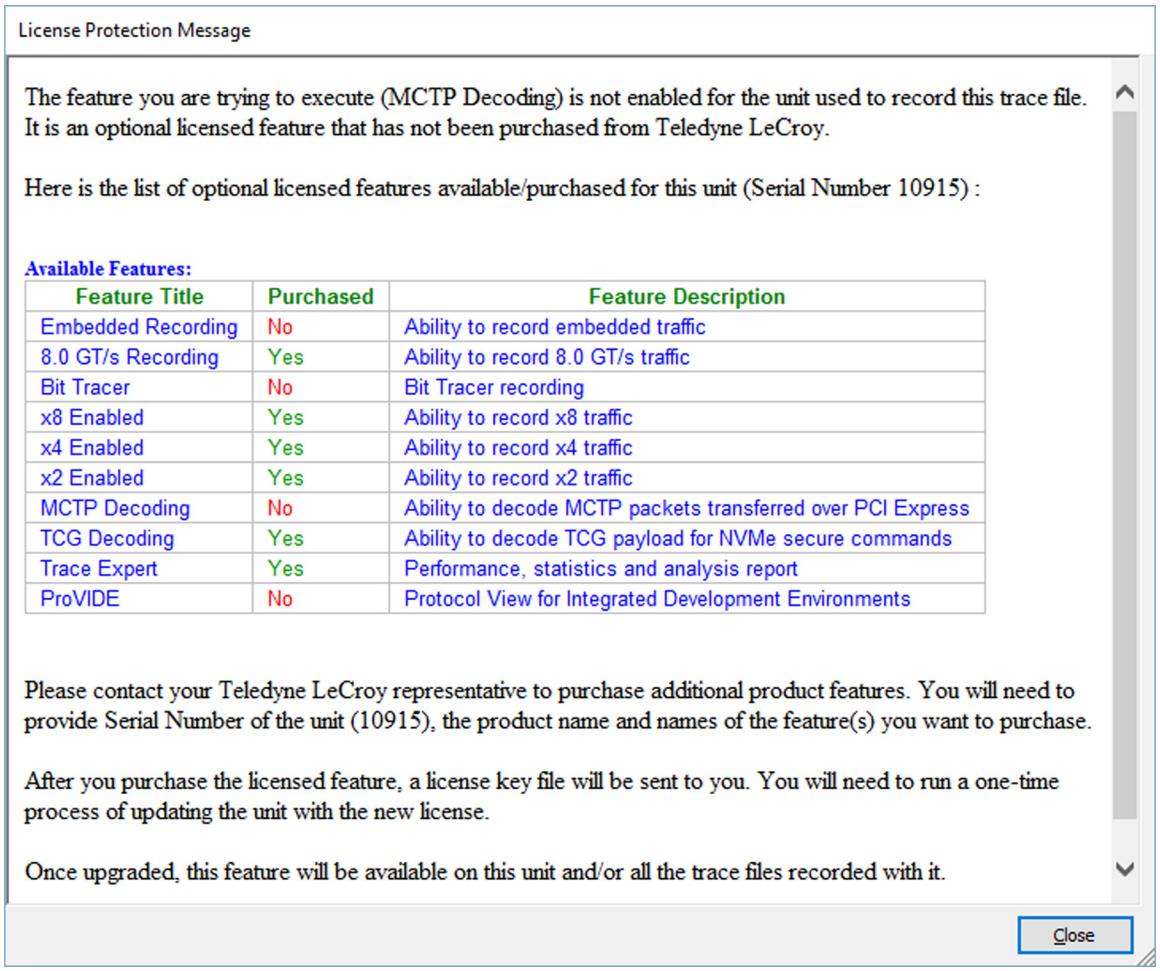


Figure 6.96: Warning Message: No MCTP License

You can decode both MCTP messages and transactions within traces by selecting CATC Trace View, Decoding Packets, Links and MCTP 

. You'll see there the transaction contains an MCTP Header and an MCTP Message. See Figure 6.97 on page 459.

6.11.13.8 MCTP Messages: Version Information

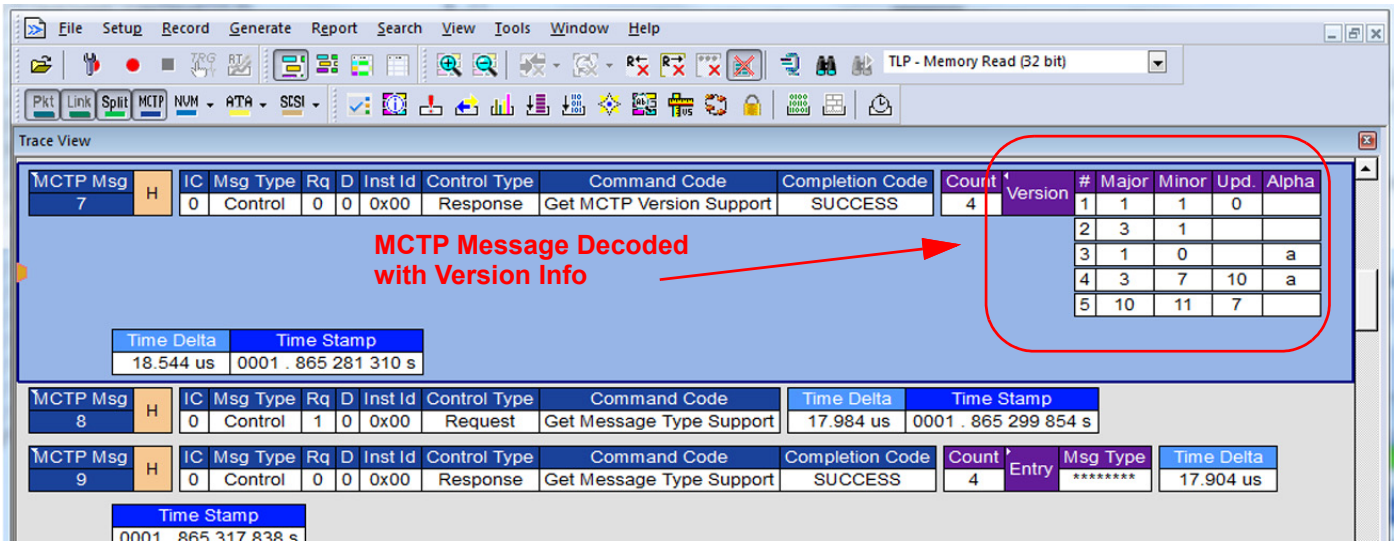


Figure 6.97: MCTP Message Decoded

6.11.13.9 MCTP Transactions

The Link Transaction will decode an MCTP Header and an MCTP Message containing a Msg Type, a Control Type and a Command Code. See Figure 6.98.

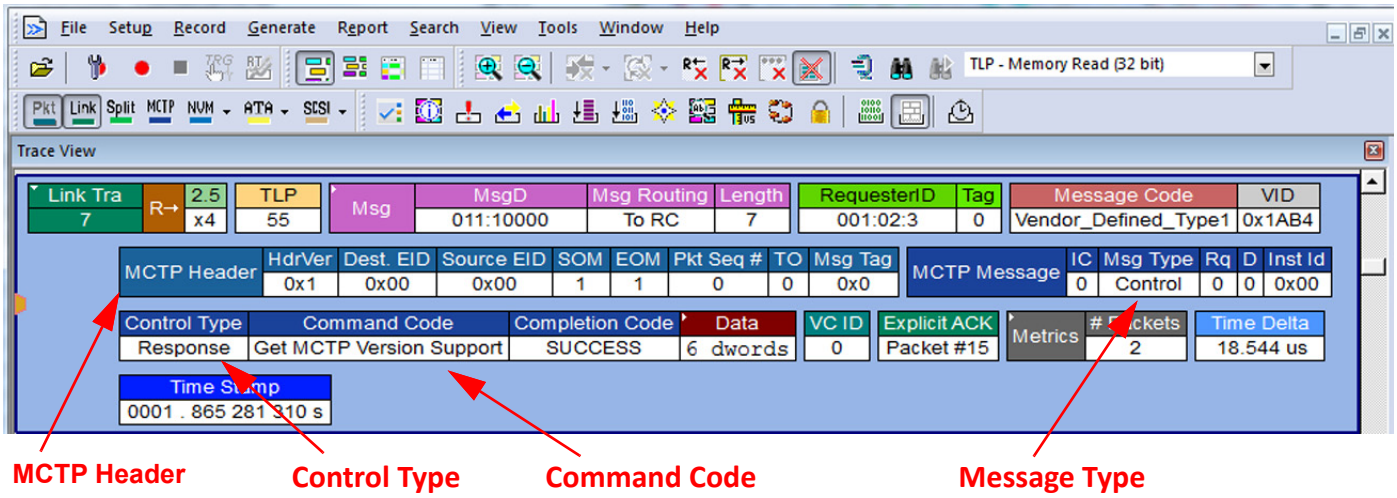


Figure 6.98: Decoding MCTP Transactions

6.11.13.10 MCTP Errors Reported

You can also display the following types of Errors from the Detailed View of the Trace:

- RsvdNotNull: RSVD field shall be 0
- InvalidHdrVer: Header version field should be set to 1
- InvalidDstEId: Destination Endpoint IDs 1 through 7 are reserved for future definition
- InvalidSrcEId: Source Endpoint IDs 1 through 7 are reserved for future definition
- ICNotNull: IC bit shall always be 0 for MCTP control messages

See Figure 6.99.

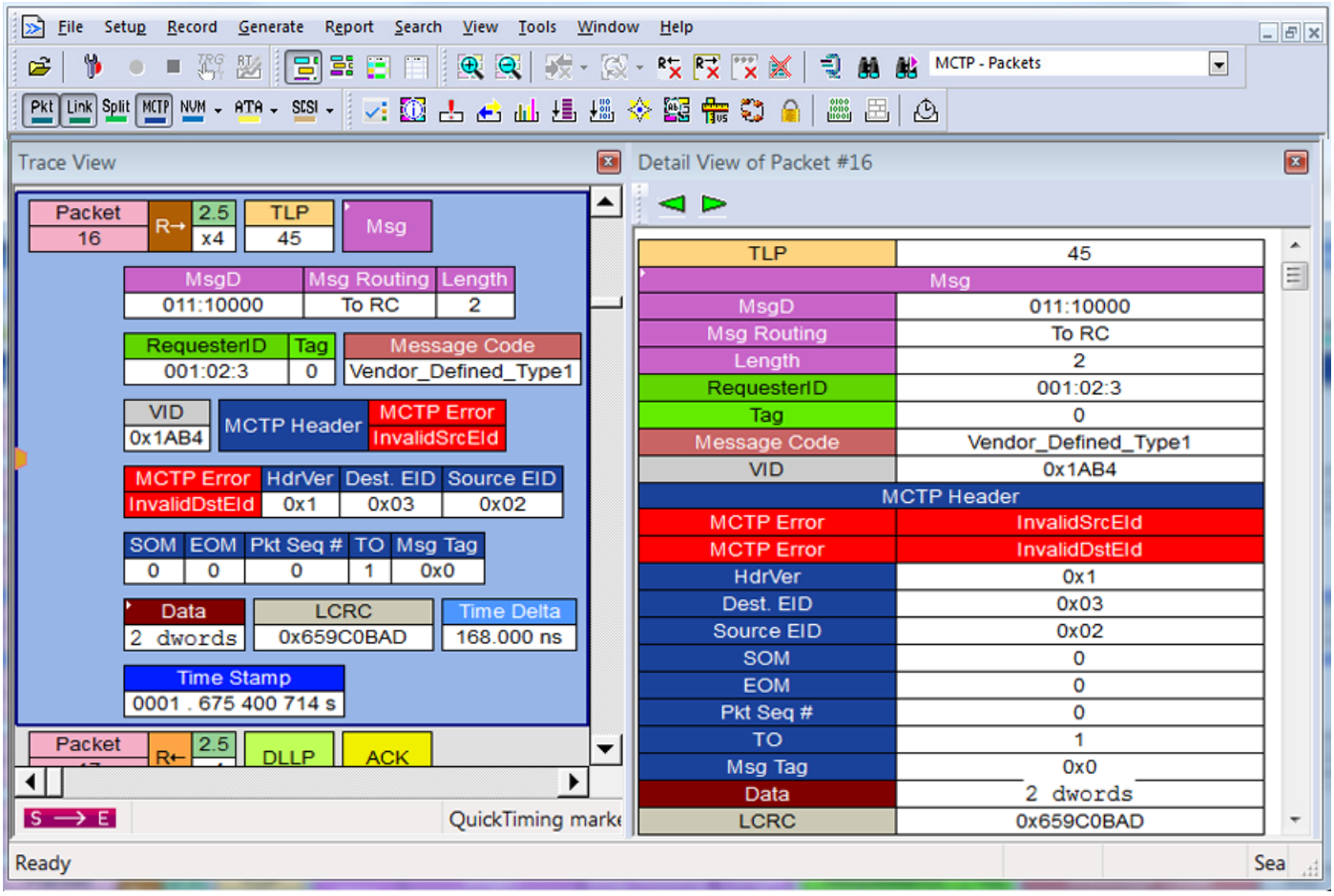


Figure 6.99: MCTP Transaction Errors Reported

6.11.13.11 MCTP Trace In Spreadsheet View

MCTP Traces can be displayed in Spreadsheet View. See Figure 6.100 on page 461.

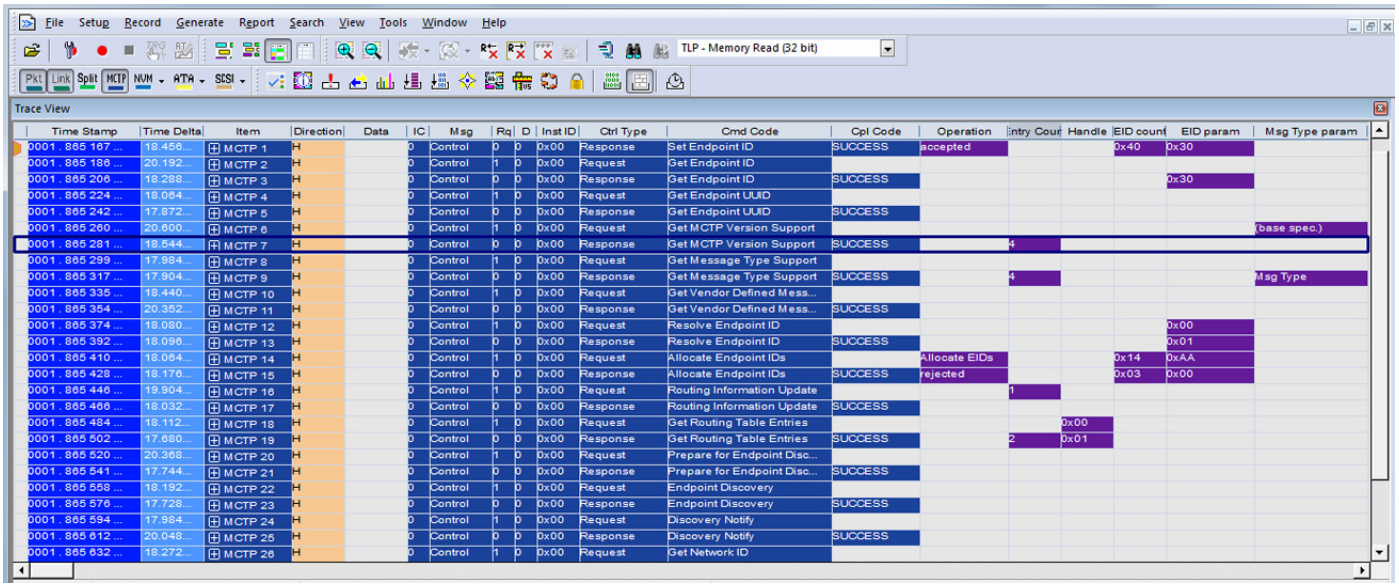


Figure 6.100: MCTP Trace in Spreadsheet View

6.11.13.12 Decoding MCTP Messages with PLDM Message Types

You can decode MCTP Messages with Platform Level Data Model (PLDM) Message types within traces by selecting CATC Trace View, Decoding Packets, Links and MCTP . You'll see that the message contains an MCTP Header and an PLDM Message. See Figure 6.101. In the example shown below there are both PLDM Requests and PLDM Responses.

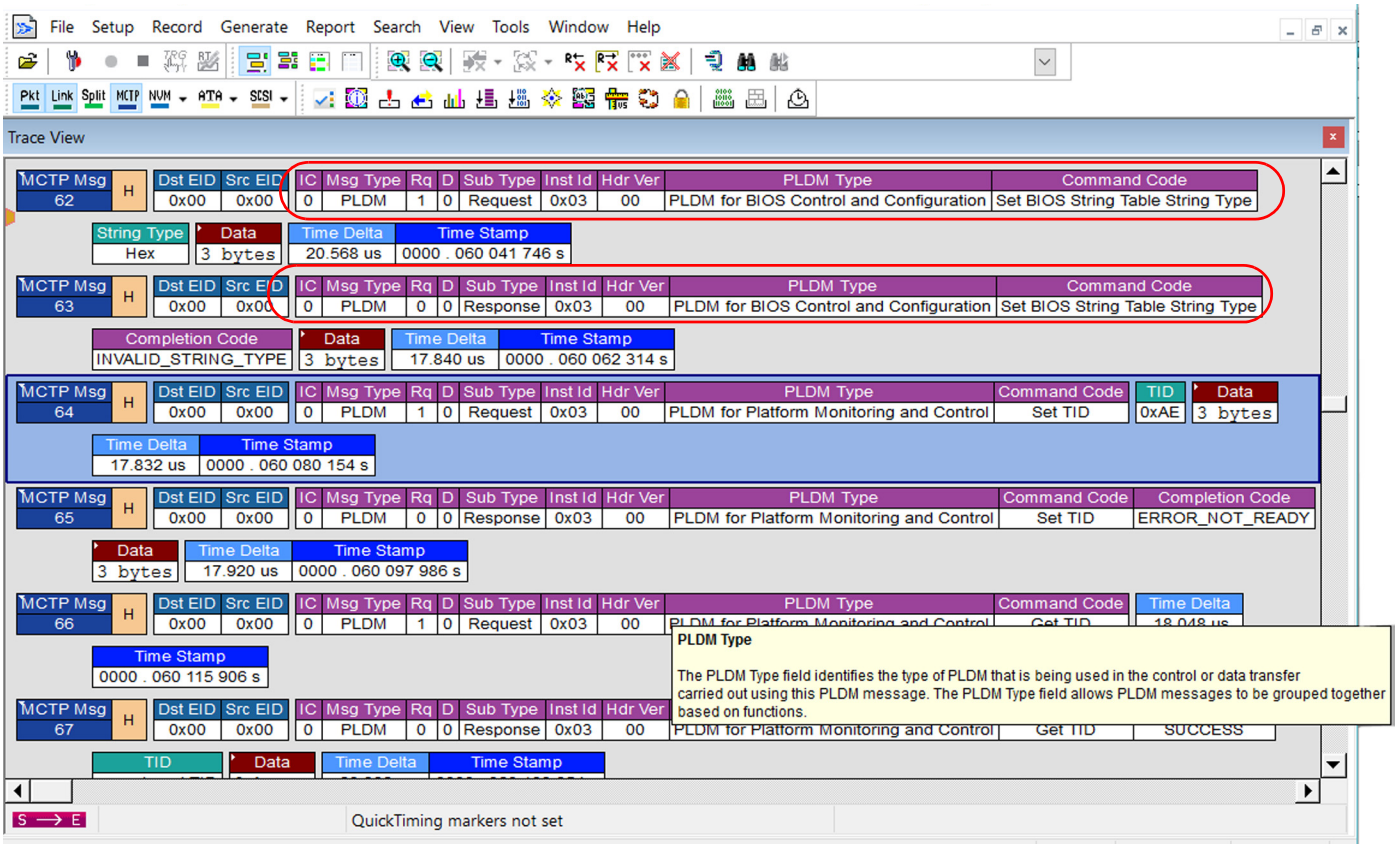


Figure 6.101: MCTP Message with PLDM Message Type

6.11.13.13 Decoding MCTP Messages with NC-SI Message Types

You can decode MCTP Messages with Network Controller Side Band Interface (NC-SI) Message types within traces by selecting CATC Trace View, Decoding Packets, Links and MCTP . You'll see that the message contains an MCTP Header and an NC-SI Message. See Figure 6.102. In the example shown below, there is an NC-SI Request packet type followed by the NC-SI packet Response.

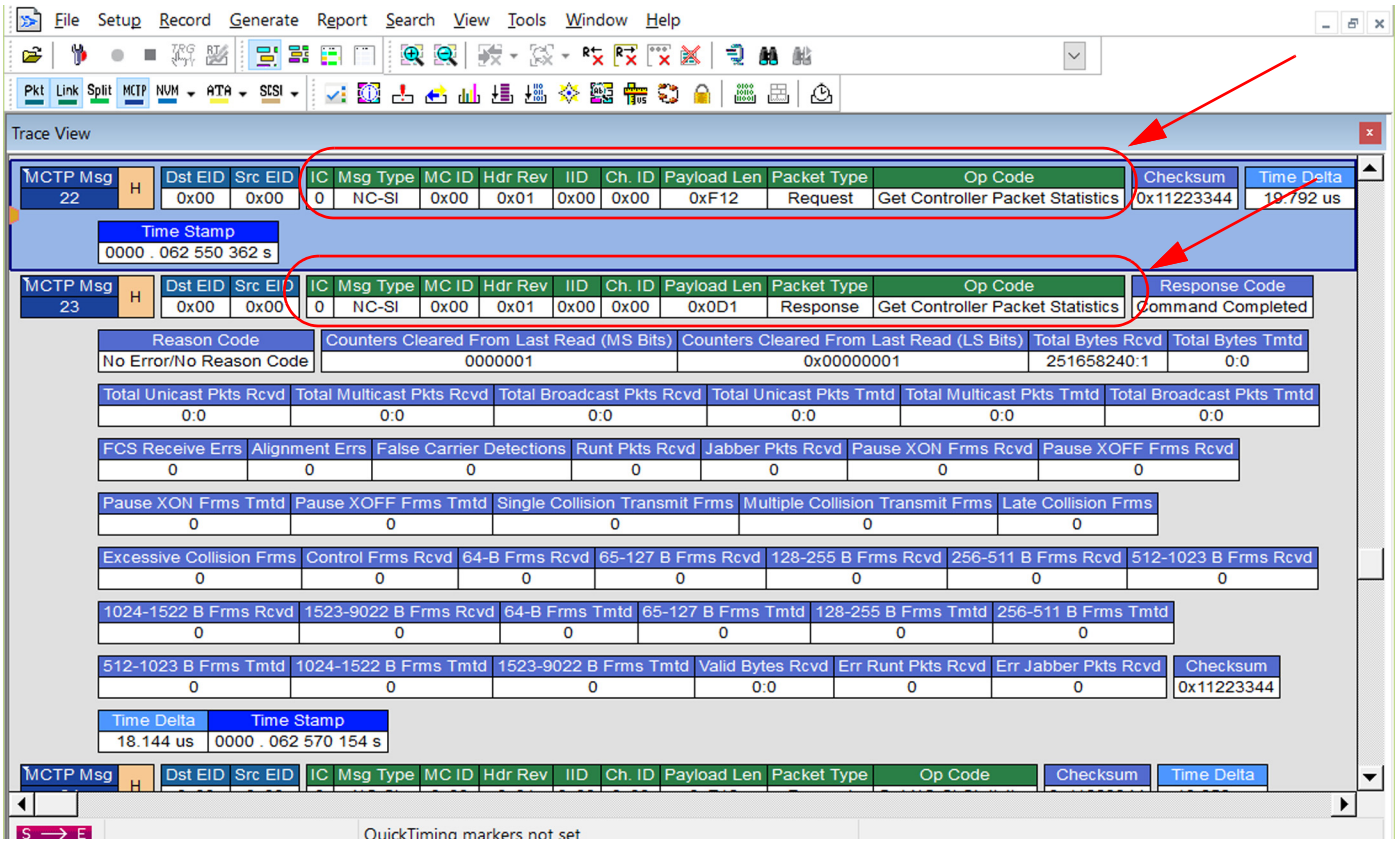


Figure 6.102: MCTP Message with NC-SI Message Type

6.11.13.14 MCTP Command with NVMe-MI Errors Decoded

The PCIe Protocol Analysis can detect, decode and display NVMe-MI errors in MCTP traffic, as shown below in Figure 6.103.

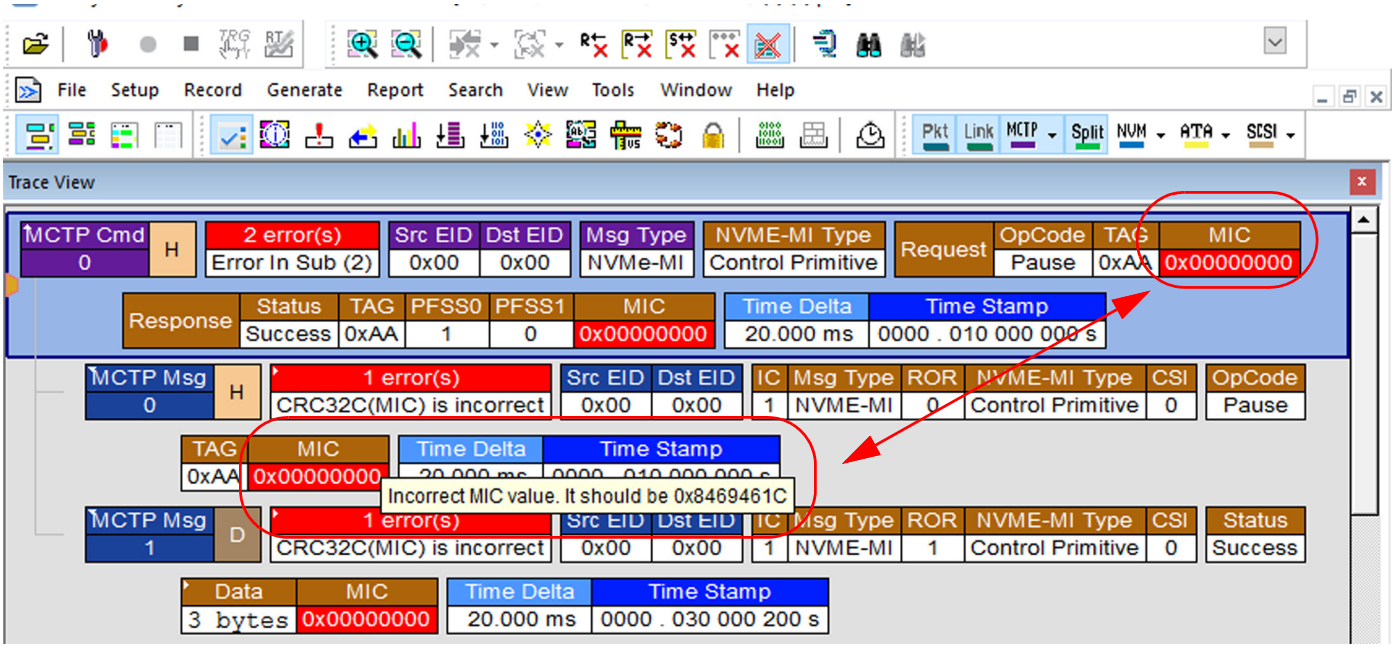


Figure 6.103: Errors Decoded In MCTP/NVMe-MI Traffic

6.11.13.15 MCTP Message Type and IC Cells

You can decode MCTP Messages and IC cells. See Figure 6.104.

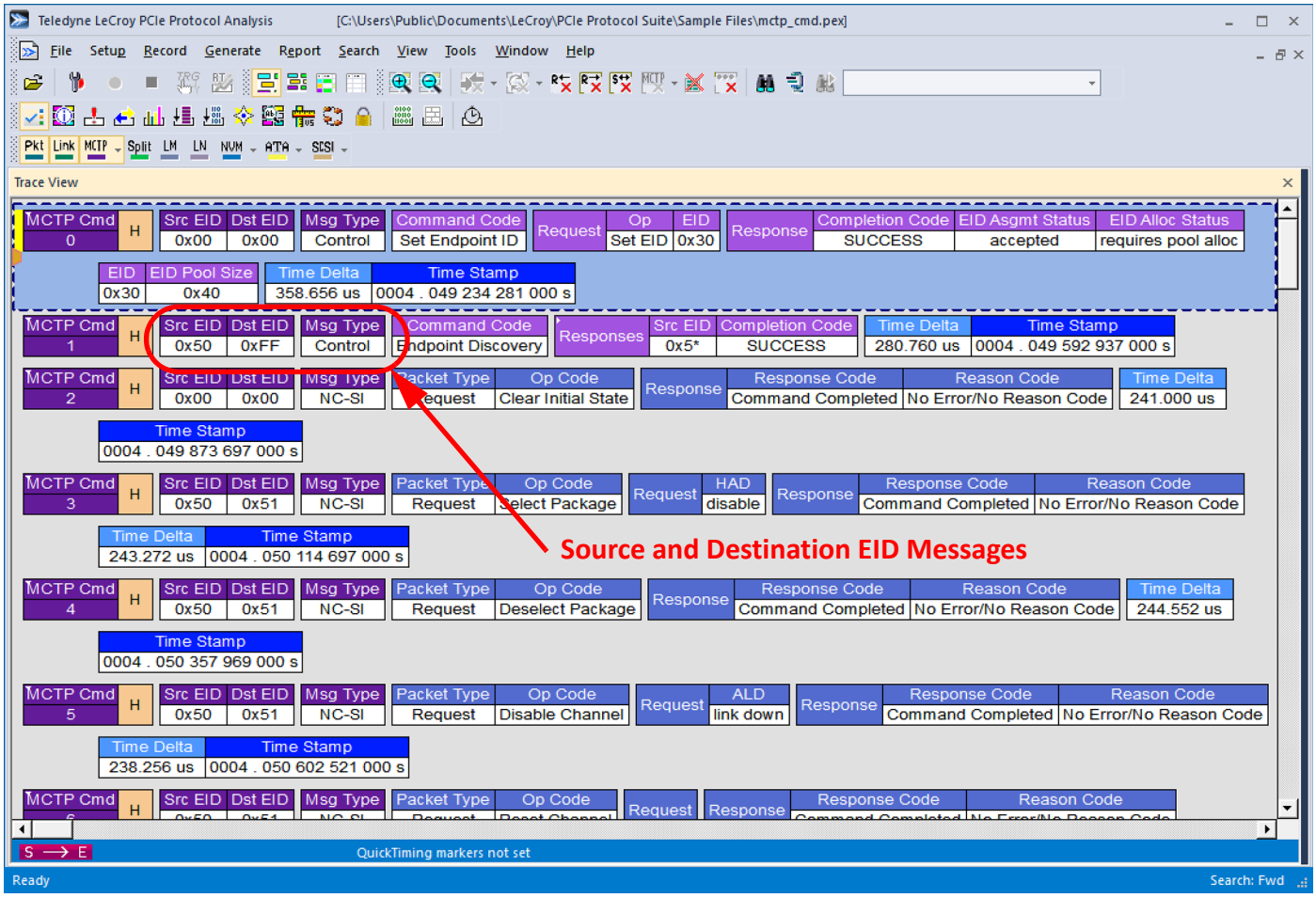


Figure 6.104: MCTP Messages Types and IC Cells Decoded

The colors of the MCTP Messages can be seen in the Display Options. See Figure 6.105 on page 466

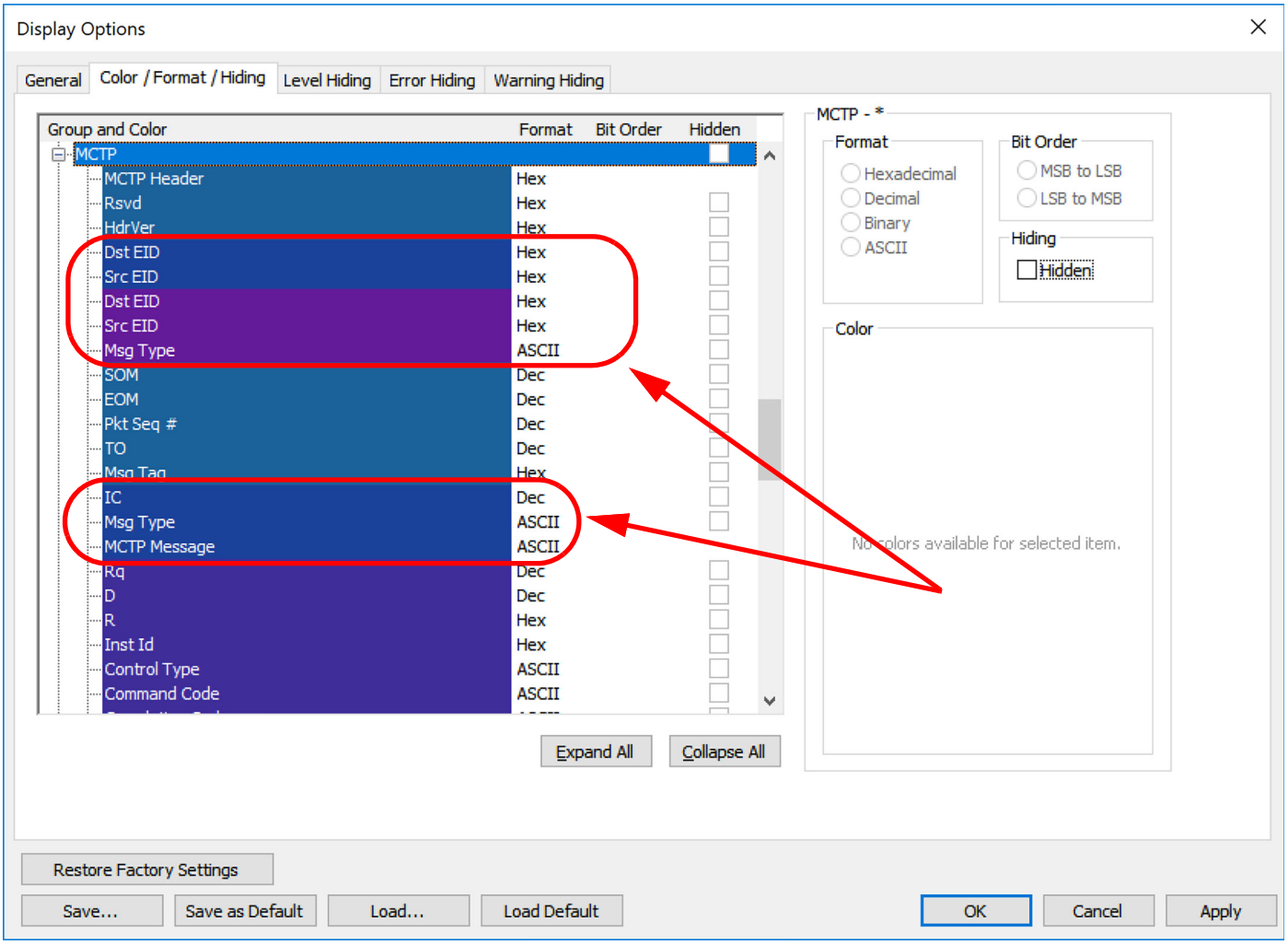


Figure 6.105: MCTP Commands and Transaction Colors from Display Options

6.11.14 Decoding MCTP Messages with SMBus Traffic

The System Management Bus (abbreviated to SMBus or SMB) is a single-ended simple two-wire bus for the purpose of lightweight communication. Most commonly it is found in computer motherboards for communication with the power source for ON/OFF instructions.

It is derived from I²C for communication with low-bandwidth devices on a motherboard, especially power related chips such as a laptop's rechargeable battery subsystem (see Smart Battery System). Other devices might include temperature, fan or voltage sensors, lid switches and clock chips. PCI add-in cards may connect to an SMBus segment.

A device can provide manufacturer information, indicate its model/part number, save its state for a suspend event, report different types of errors, accept control parameters and return status. The SMBus is generally not user configurable or accessible. Although SMBus devices usually can't identify their functionality, a new PMBus coalition has extended SMBus to include conventions allowing that.

The Summit T34 can capture SMBus traffic and display it as part of an MCTP message along with normal PCIe Data traffic, as shown in Figure 6.106 and Figure 6.107 on page 468.

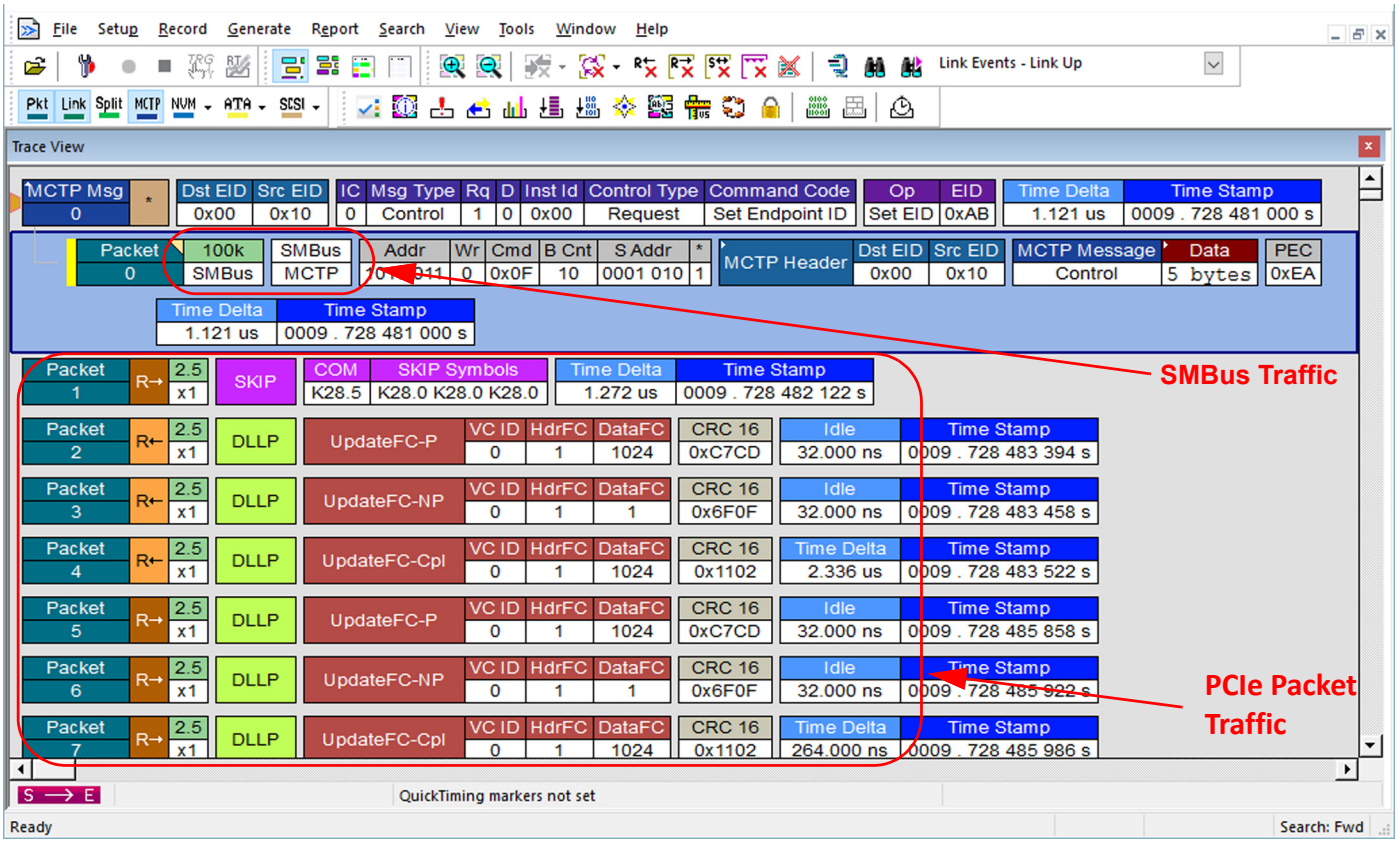


Figure 6.106: MCTP Message with SMBus Sideband Traffic and PCIe Packet Traffic

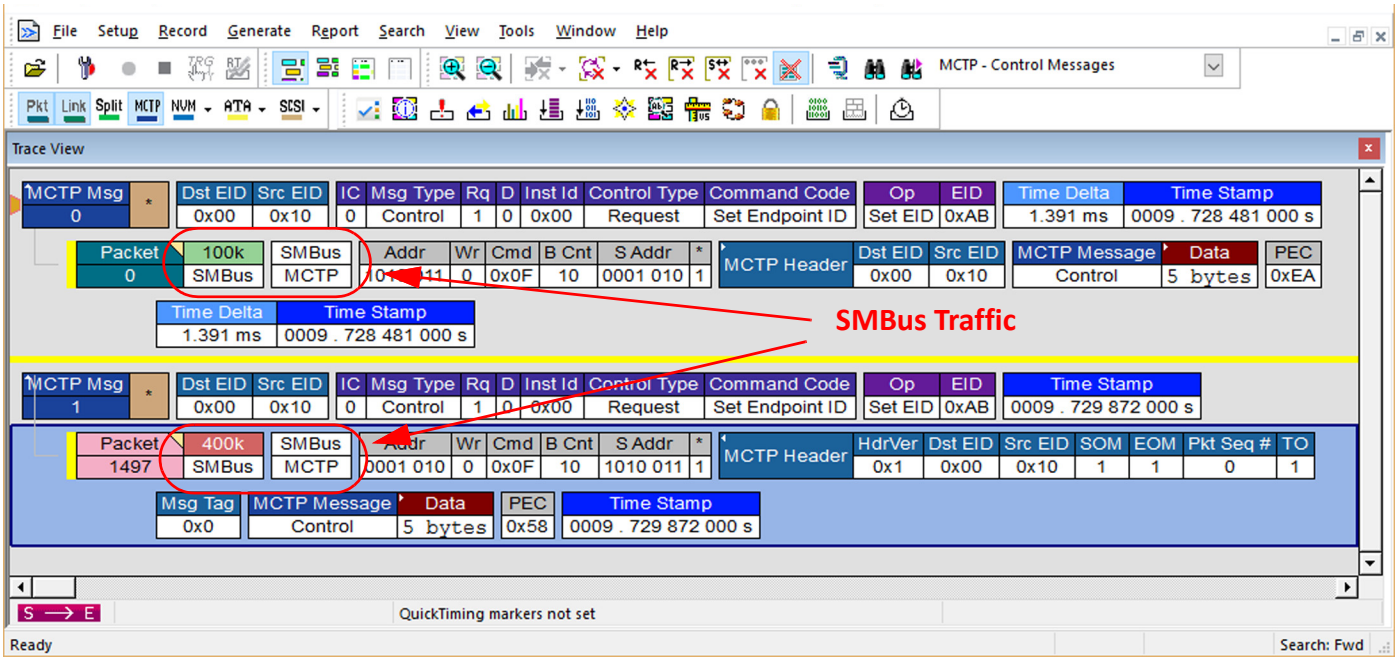


Figure 6.107: SMBus Traffic within two MCTP Messages

Sideband Traffic: Displayed or Hidden

You can decide to Display or Hide Sideband traffic (this includes SMBus traffic) by selecting the Hide Sideband icon in the toolbar. This will Hide the SMBus Traffic. Figure 6.108 shows Sideband traffic displayed. Figure 6.109 on page 470 shows the SMBus traffic Hidden.

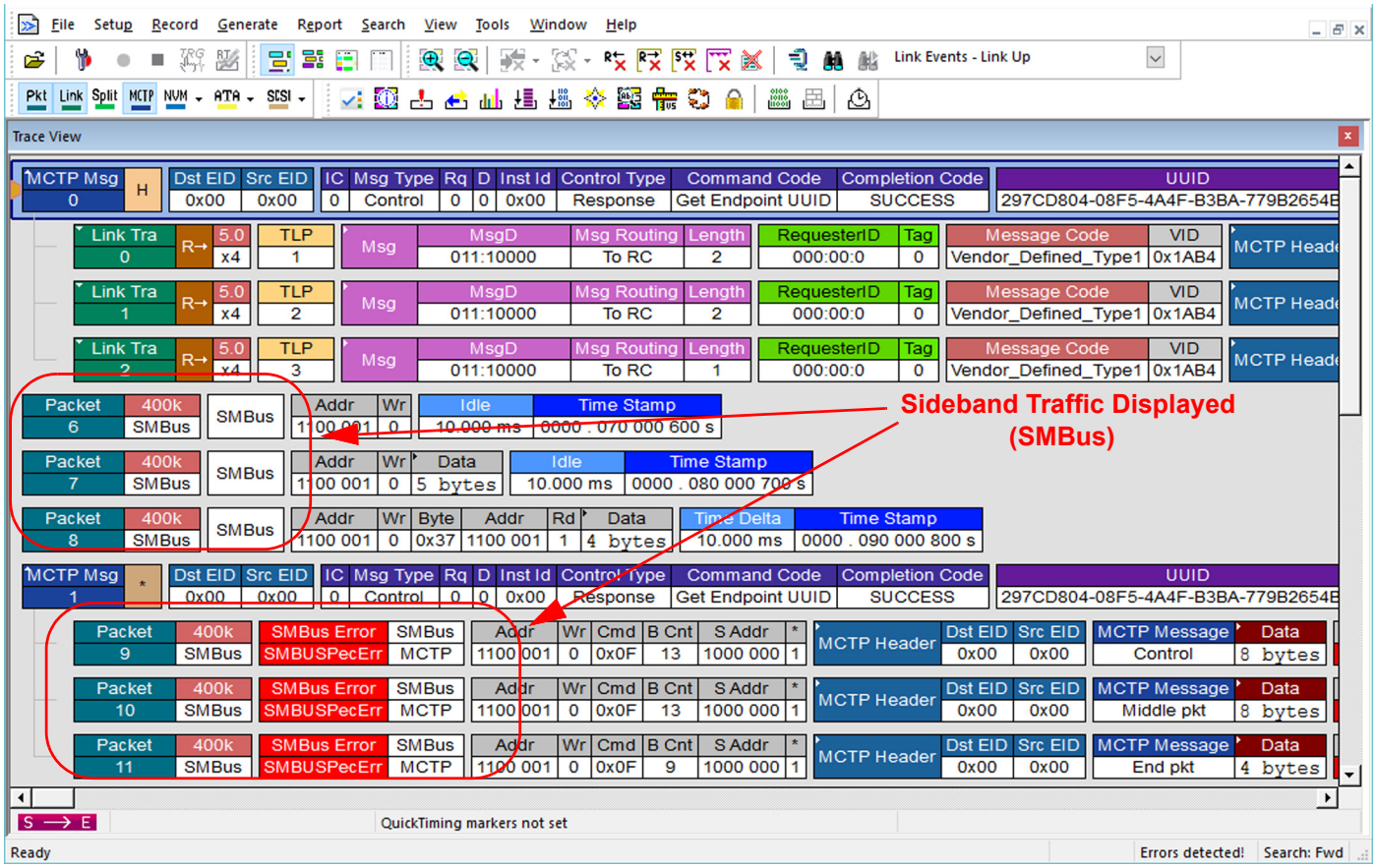


Figure 6.108: Displaying Sideband Traffic (SMBus)

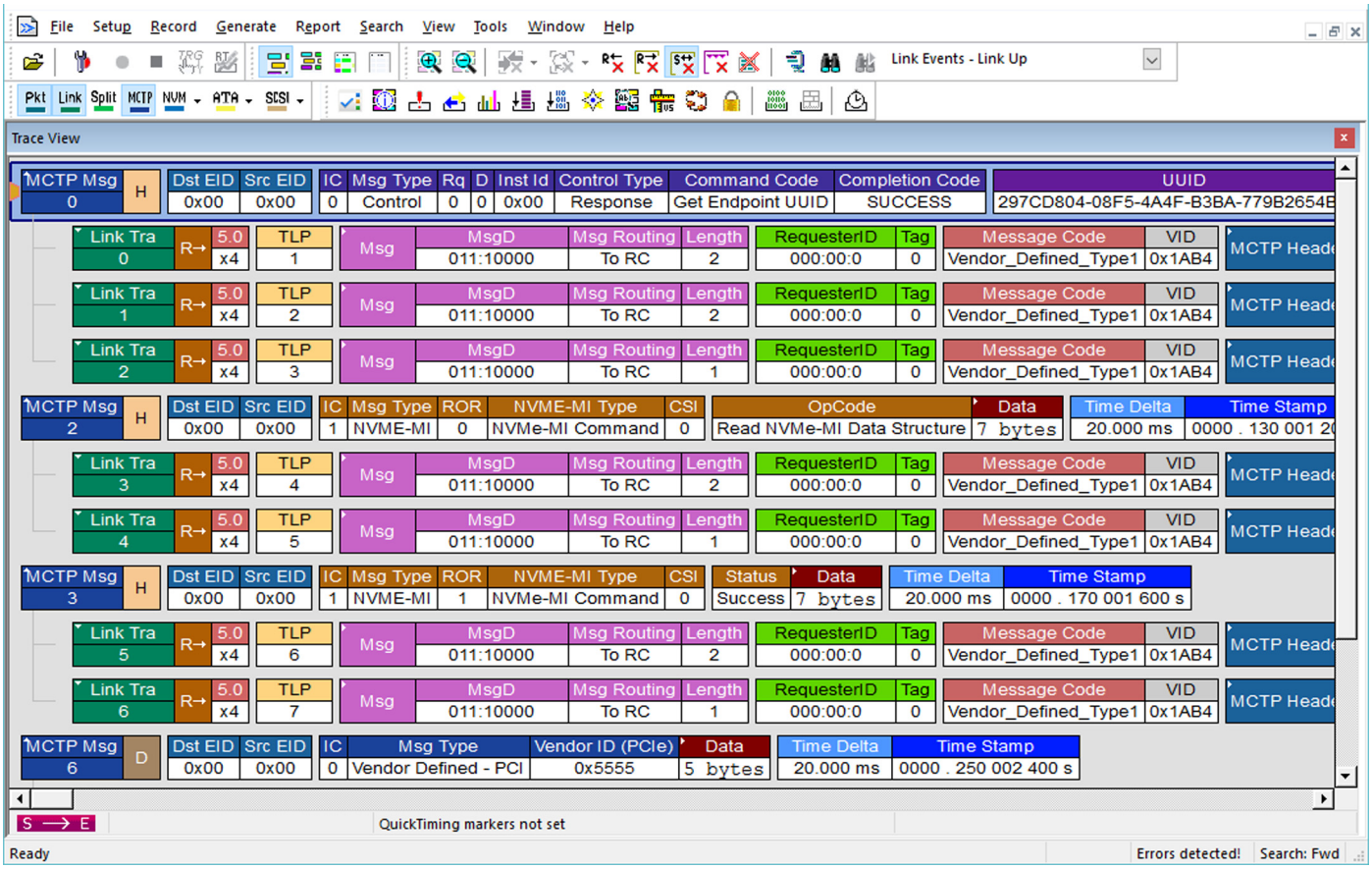


Figure 6.109: Hiding Sideband Traffic (SMBus)

If you compare Figure 6.108 on page 469 and Figure 6.109 you'll see that all the SMBus traffic has been hidden in Figure 6.109. Specifically, Packets 6 - Packet 8 are hidden, which had SMBus traffic and the SMBus traffic in Packets 9 and 10, which were part of MCTP Message 1 are also hidden.

SMBus Errors

The Summit T34 analyzer can detect a wide variety of SMBus errors (as shown in Figure 6.110 and Figure 6.111 on page 472).

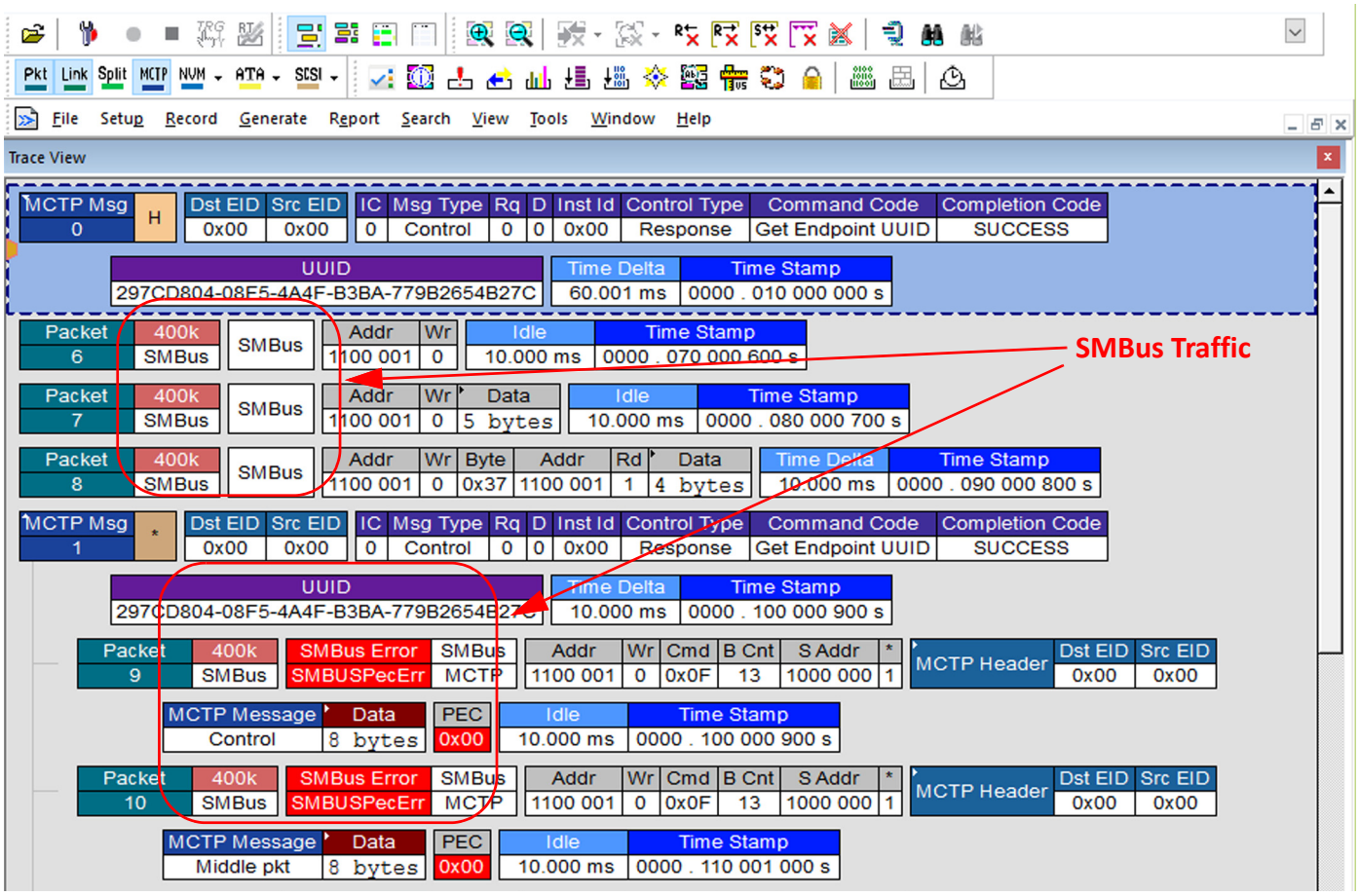


Figure 6.110: SMBus Traffic within two MCTP Messages with Errors

SMBus Error Tooltip

If you scroll over each SMBus Error a tooltip with a detailed explanation of the error will popup. See Figure 6.111.

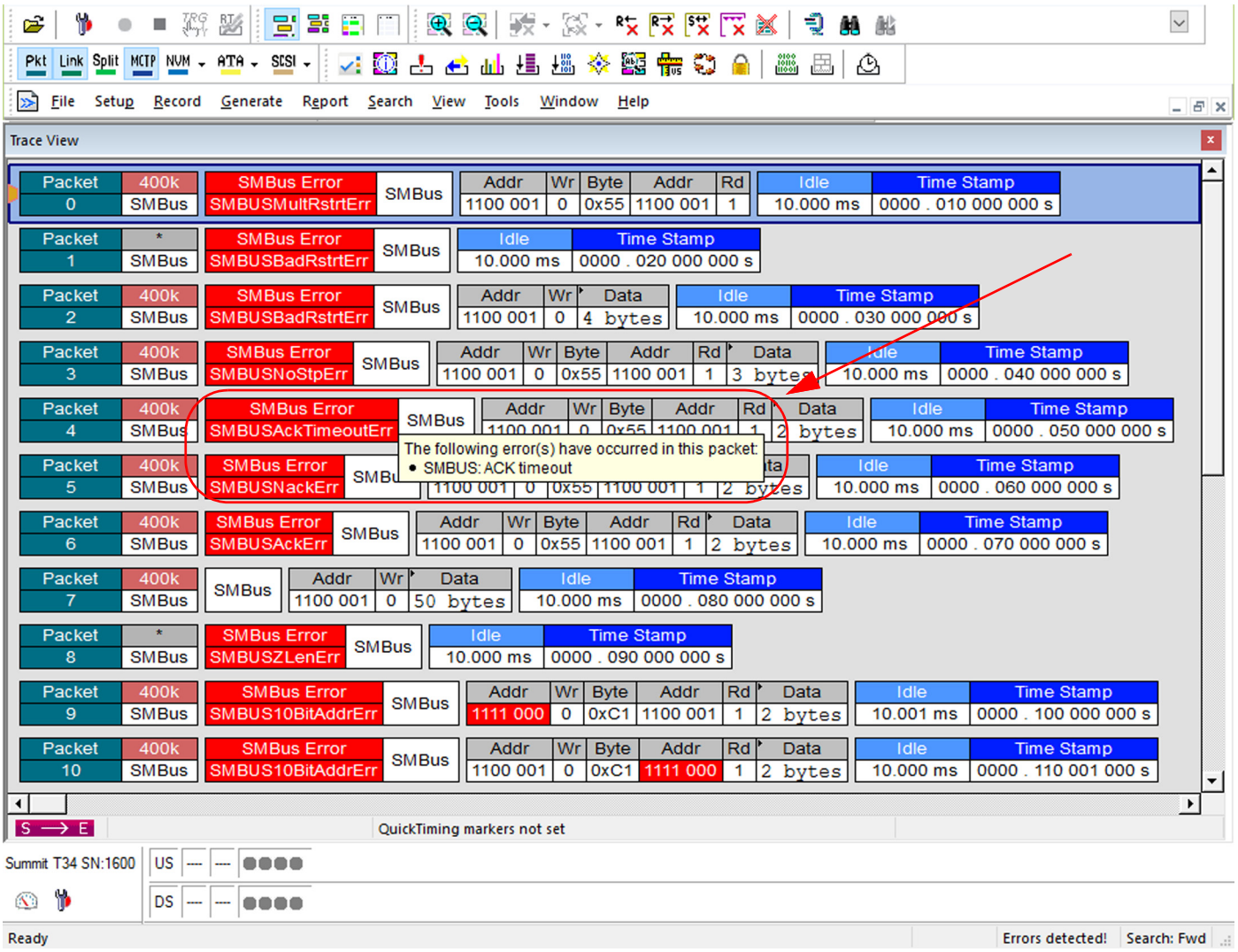


Figure 6.111: Decoding SMBus with Errors

Traffic Summary Report: SMBus Errors

Another way of displaying the SMBus errors is to select the Traffic Summary Report (as shown in Figure 6.112).

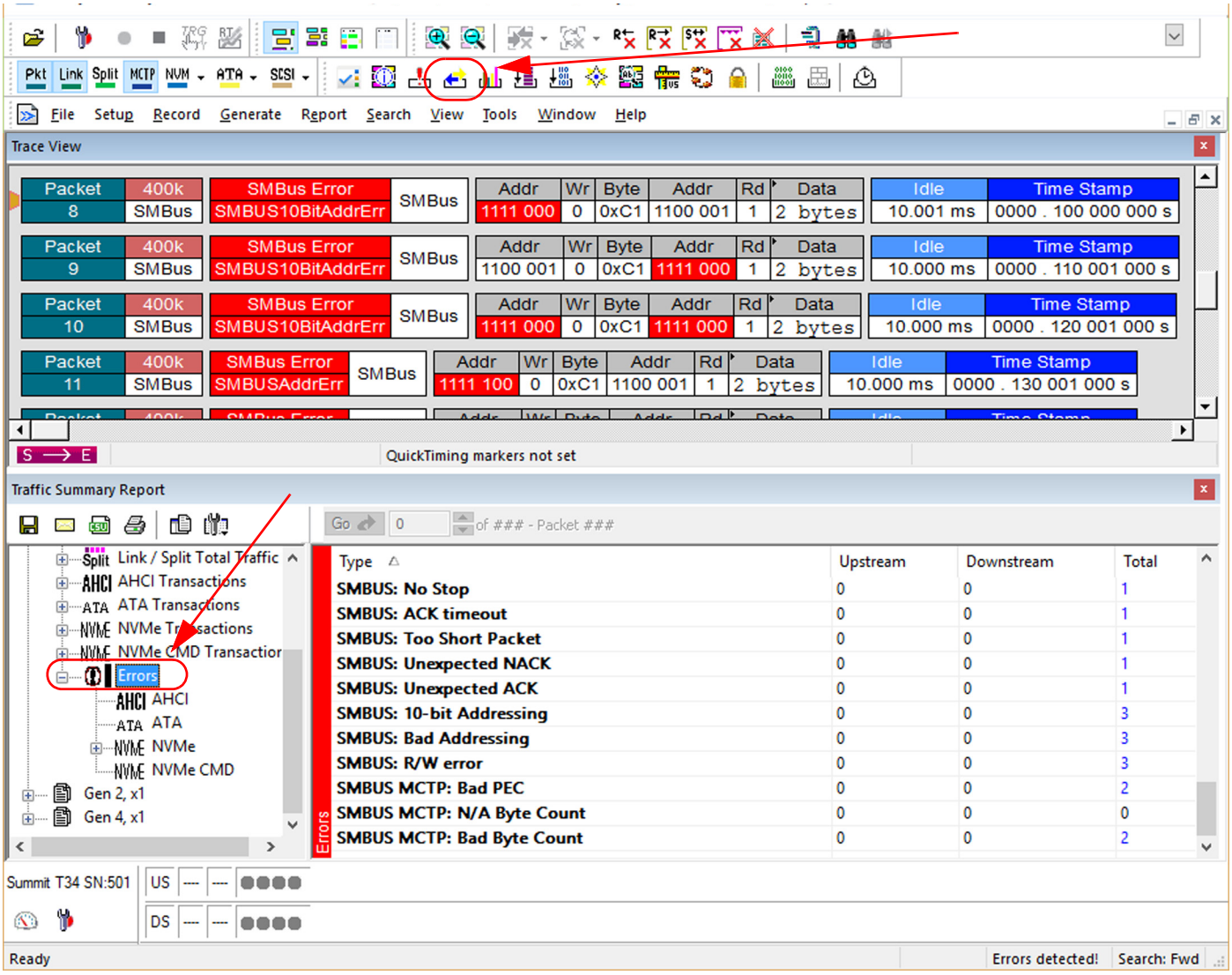


Figure 6.112: Traffic Summary Report: SMBus Errors

The complete set of SMBus errors that the Summit T34 can detect is contained in the table below: Table 6.9.

TABLE 6.9: SMBus Errors

Bus Error	Description
SMBUSLongPktErr	SMBUS: Too Long Packet
SMBUSMultRstrtErr	SMBUS: More Than One Restart
SMBUSBadRstrtErr	SMBUS: Bad Restart
SMBUSNoStpErr	SMBUS: No Stop
SMBUSAckTimeoutErr	SMBUS: ACK Timeout
SMBUSZLenErr	SMBUS: Too Short Packet
SMBUSNackErr	SMBUS: Unexpected NACK
SMBUSAckErr	SMBUS: Unexpected ACK
SMBUS10BitAddrErr	SMBUS: 10-bit Addressing
SMBUSAddrErr	SMBUS: Bad Addressing
SMBUSRwErr	SMBUS: R/W error
SMBUSPecErr	SMBUS MCTP: Bad PEC
SMBUSNaByteCntErr	SMBUS MCTP: N/A Byte Count
SMBUSByteCntErr	SMBUS MCTP: Bad Byte Count

6.11.15 Decoding SMBus with Address Resolution Protocol (ARP)

The PCIe Protocol Analysis can decode SMBus traffic with Address Resolution Protocol as shown below in Figure 6.113.

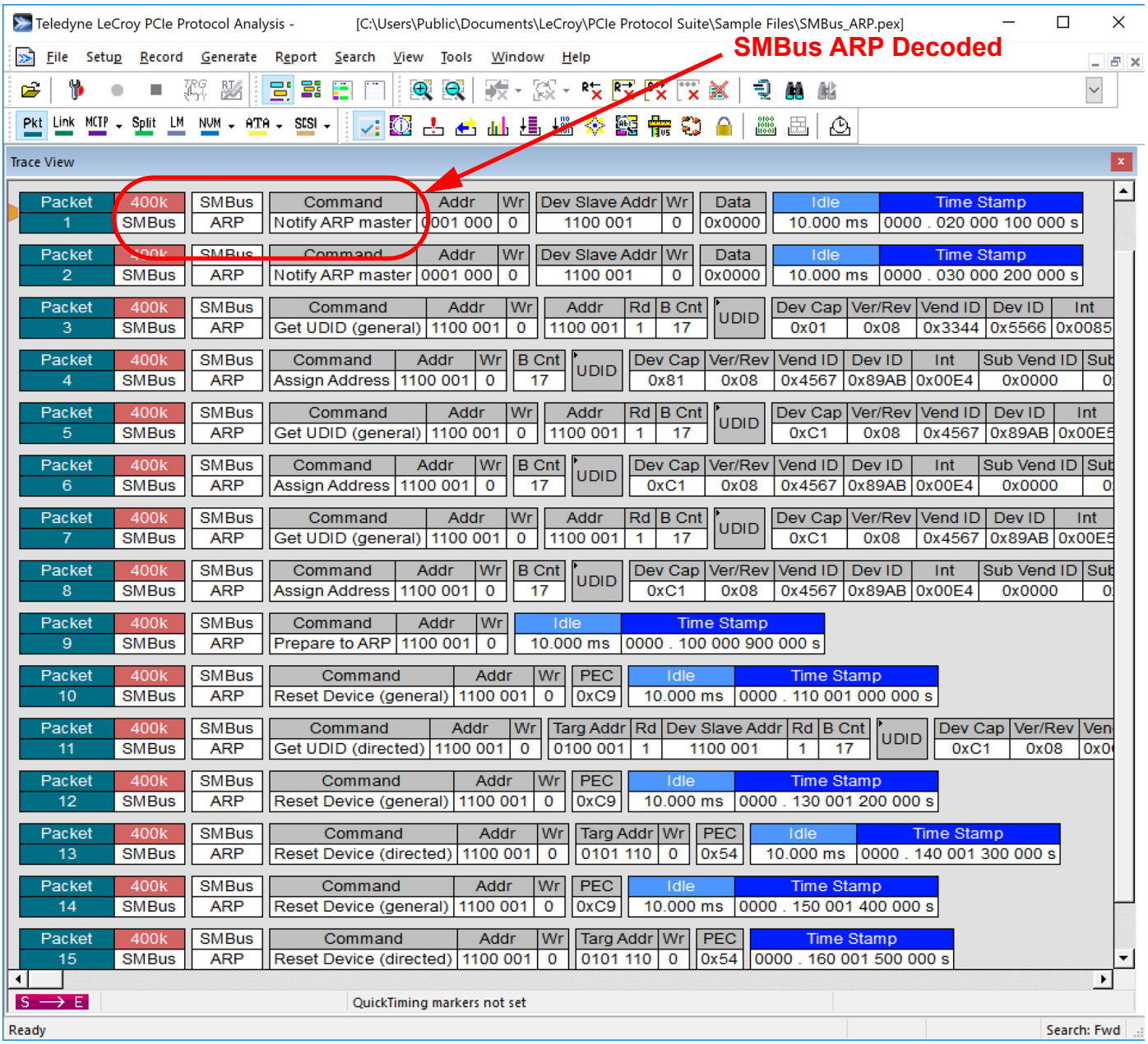


Figure 6.113: SMBus Address Resolution Protocol Decoded

6.11.16 Decoding MCTP Traffic with Vendor Defined Messages (VDM)

The PCIe Protocol Analysis can decode MCTP traffic with Vendor Defined Messages (VDM) as shown below in Figure 6.114.

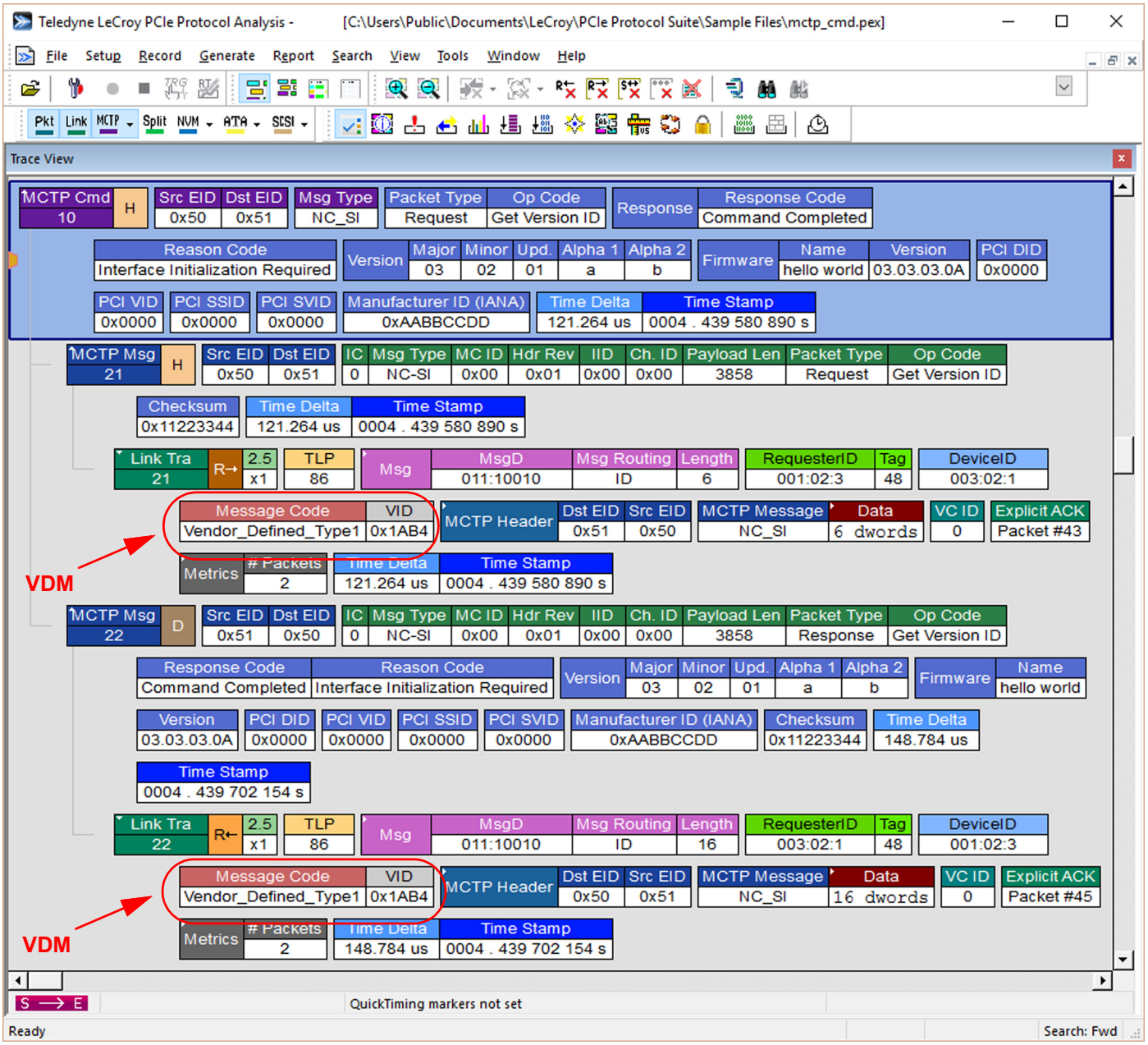


Figure 6.114: MCTP Traffic: Decoding Vendor Defined Messages (VDM)

6.11.17 Decoding Side Band Signals

There are a number of side band signals which are decoded by the PCIe Protocol Analysis and will be displayed in the Trace View:

- PERST# (Asserted and Deasserted)
- WAKE# (Asserted and Deasserted)
- CLKREQ# (Asserted and Deasserted)

These signals are displayed as Link Events. They can be found in the trace by using the **Search -> Go to -> Link Event** function from the Main Toolbar.

Since these signals have no direction they will be displayed once in the upstream direction and once in the downstream direction.

Note: If left floating in the bus, PERST#, WAKE# and CLKREQ# may show up in the trace as events. Make sure these signals are pulled up according to the specification. During beacon phase there might be transitions of WAKE# that will show up in the trace.

6.11.18 PMUX Channel ID Found and PMUX Packet Error Decoded in Trace

In the trace both the PMUX Channel ID was found and a Packet PMUX Error was decoded. See Figure 6.115.

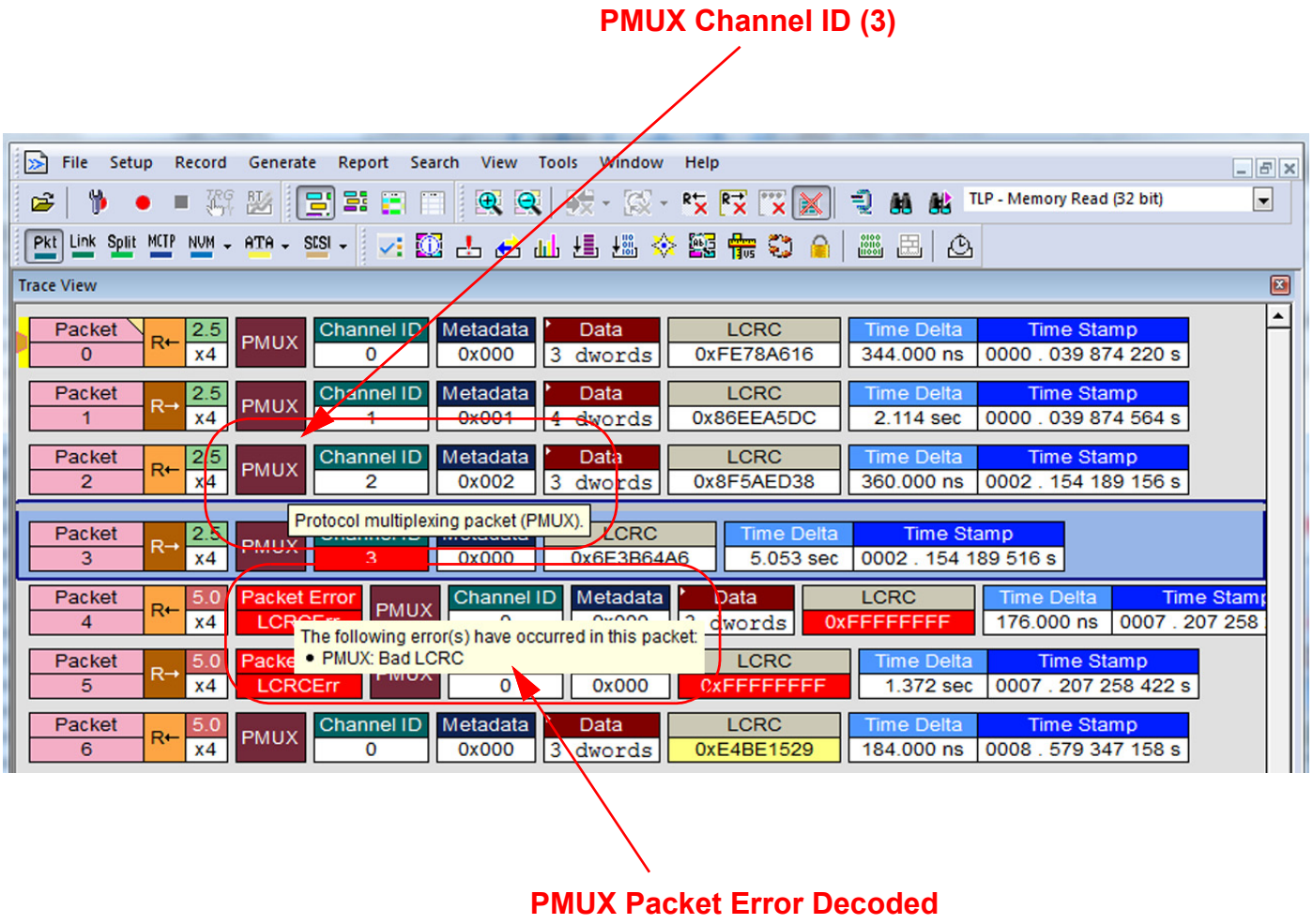


Figure 6.115: PMUX Channel ID (3) Found in Trace and Packet Error Decoded

6.11.19 Decoding Traces with Different Class Codes

PCIe Protocol Analysis initially assumes all traces have unknown class codes and that the decoder selected and trace class codes are the same. If after decoding the trace, the class codes of the trace and the decoder selected are different, a warning message pops up showing the correct class code of the trace.

Example: Loading an NVMe Trace and Decoding for ATA

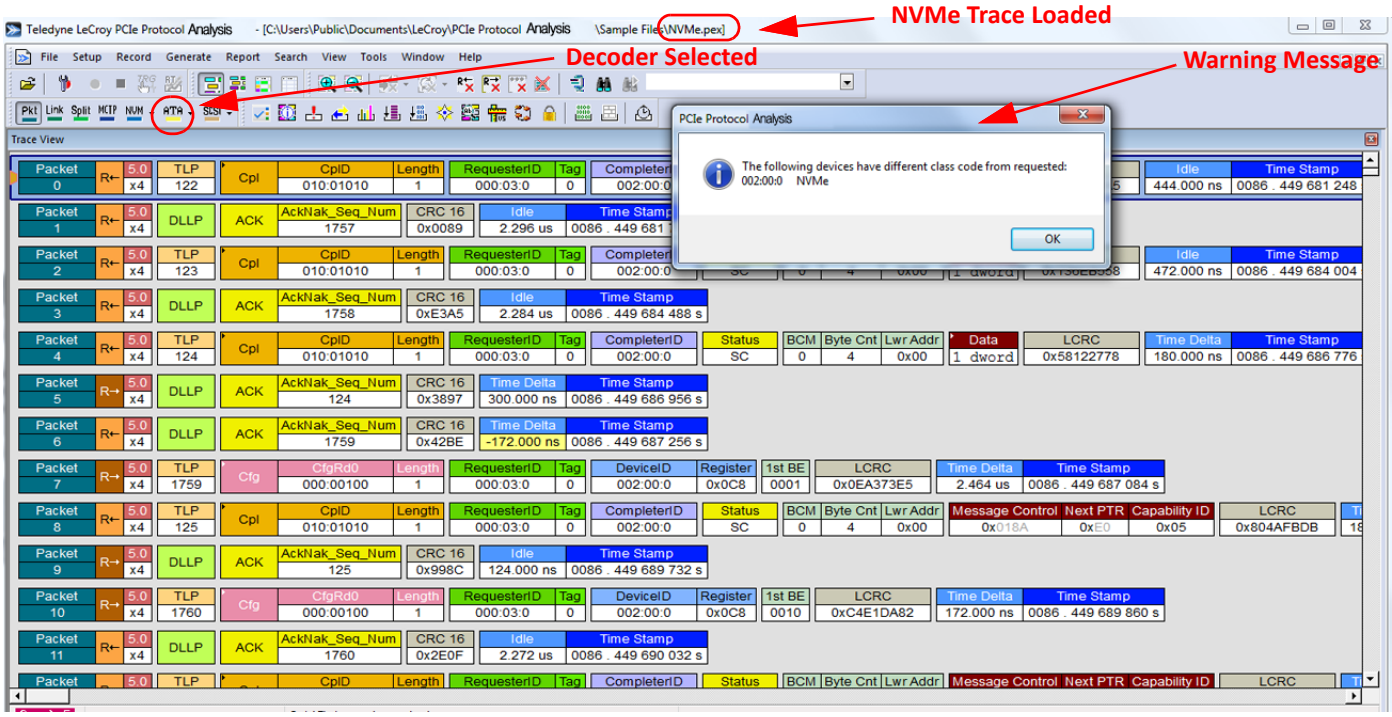


Figure 6.116: NVMe Trace Loaded Different Than ATA Decoder Selected

Example: Loading a PQI Trace and Decoding for NVMe

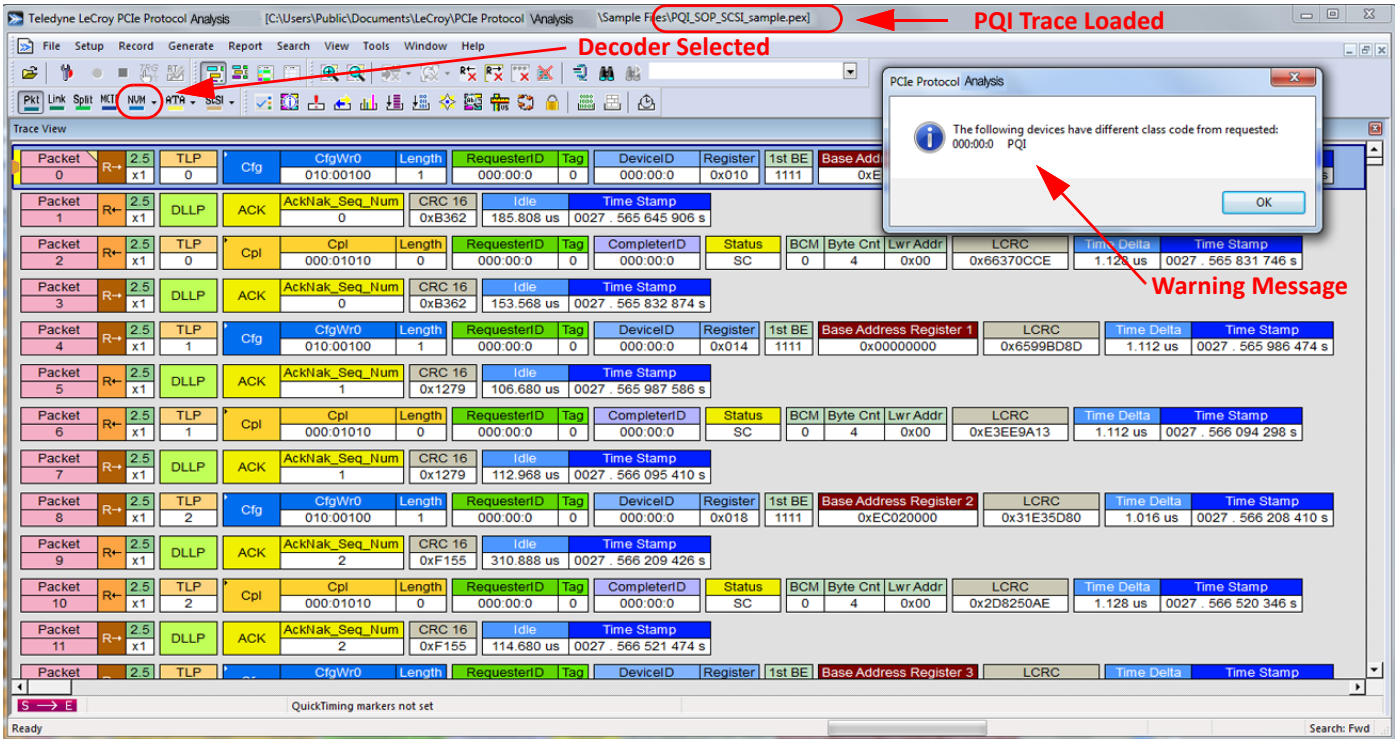


Figure 6.117: PQI Trace Loaded Different Than NVMe Decoder Selected

6.11.20 Decoding PCI-SIG Vendor Defined Messages (VDMs)

PCI-SIG VDMs can be decoded as shown below in Figure 6.118.

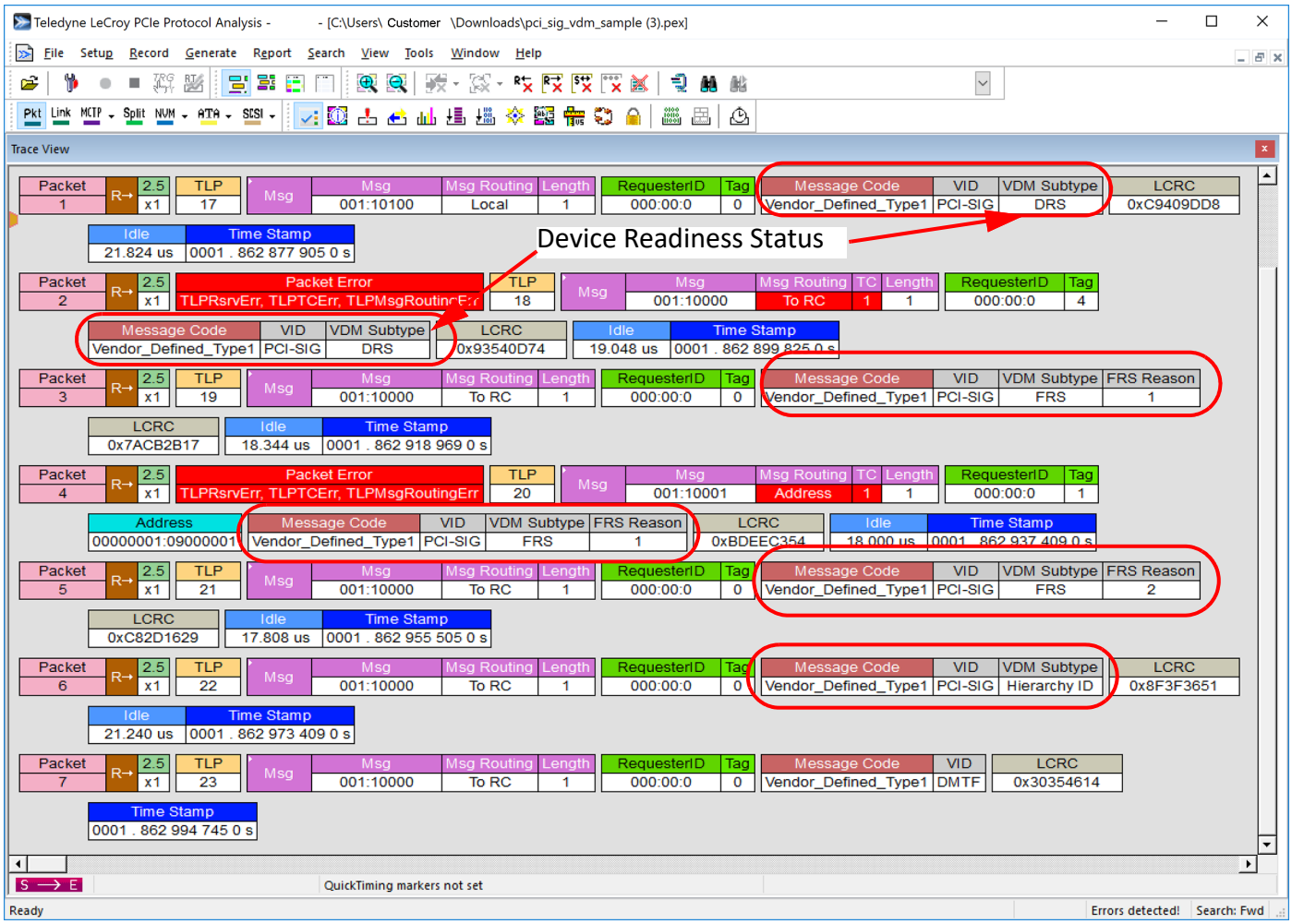


Figure 6.118: Decoding PCI-SIG VDMs

You can roll the cursor over each VDM to display it's tooltip. The one for Device Readiness Status is shown below (see Figure 6.119).

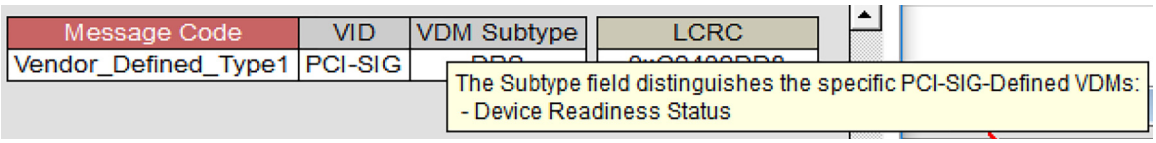


Figure 6.119: Device Readiness Status Tooltip

You can also bring up the decoded trace in Detailed mode (see Figure 6.120 on page 482).

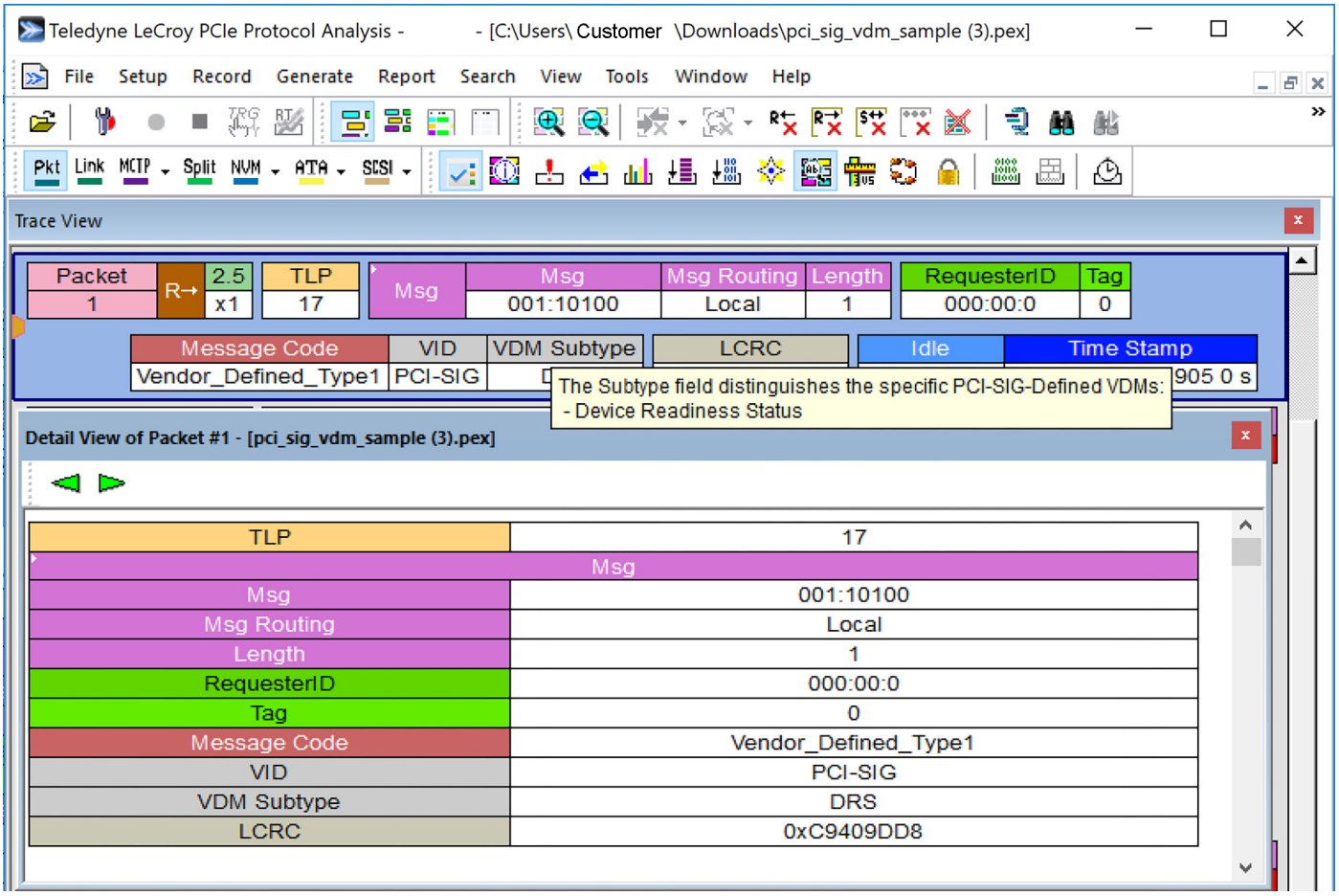


Figure 6.120: Decoding PCI-SIG VDM: Displayed in Detailed Mode

Other VDM Messages include:

- LN
- FRS
  - Reason 1: DRS Message Received
  - Reason 2: D3 Hot to D0 Transition Completed
- Hierarchy ID
- DMTF

6.11.21 Decode for NVMe 1.3c Specification

The PCI Express Analysis includes decoding for the following NVMe 1.3c Specification:

- Command Specific Status Code
- Opcodes for Admin commands
- Doorbell Buffer Config commands
- Device Self-Test command
- Directive Receive command
- Directive Send command
- Firmware Commit
- Features
- Get Log Page
- Identify command
- NVMe-Mi Receive command
- NVMe-MI Send command
- Format NVM
- Sanitize command
- Write
- Write Zeros
- Identifier Format 7.10

Some examples are shown below (see Figure 6.121 through Figure 6.124 on page 486).

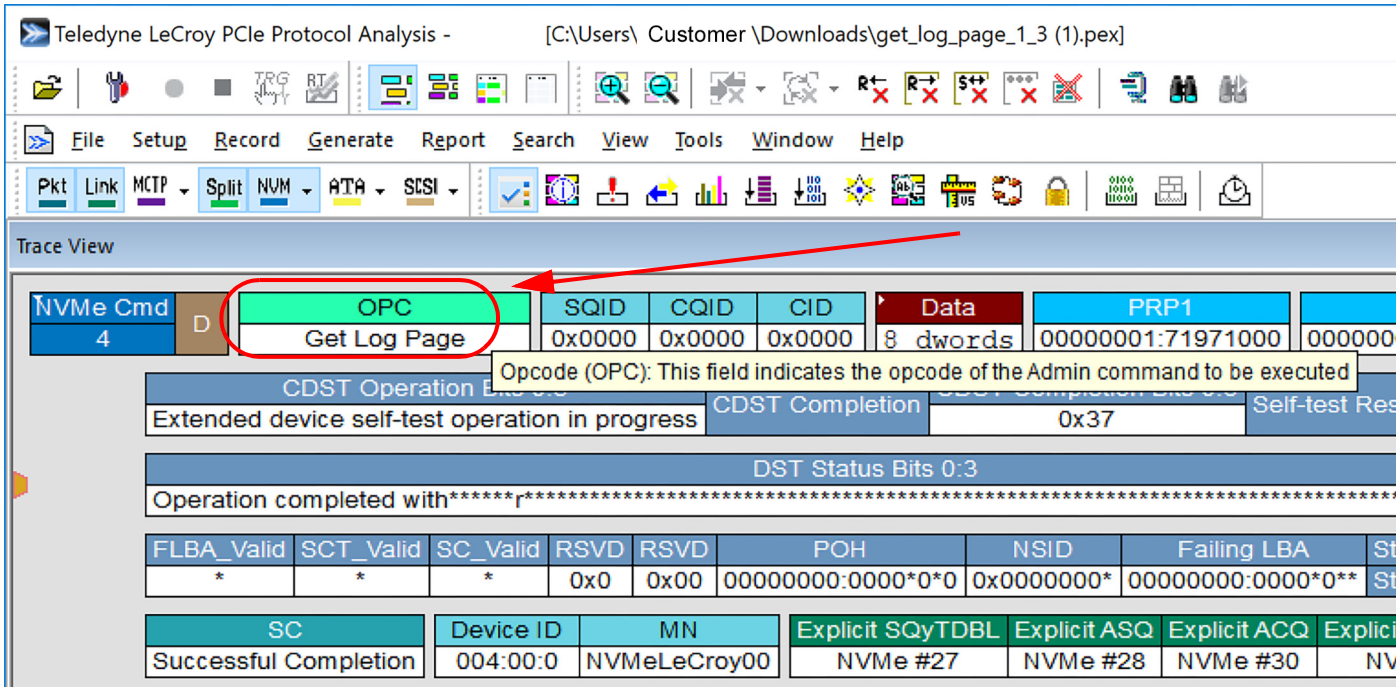


Figure 6.121: NVMe 1.3c Spec: Decodes --> Get Log Page

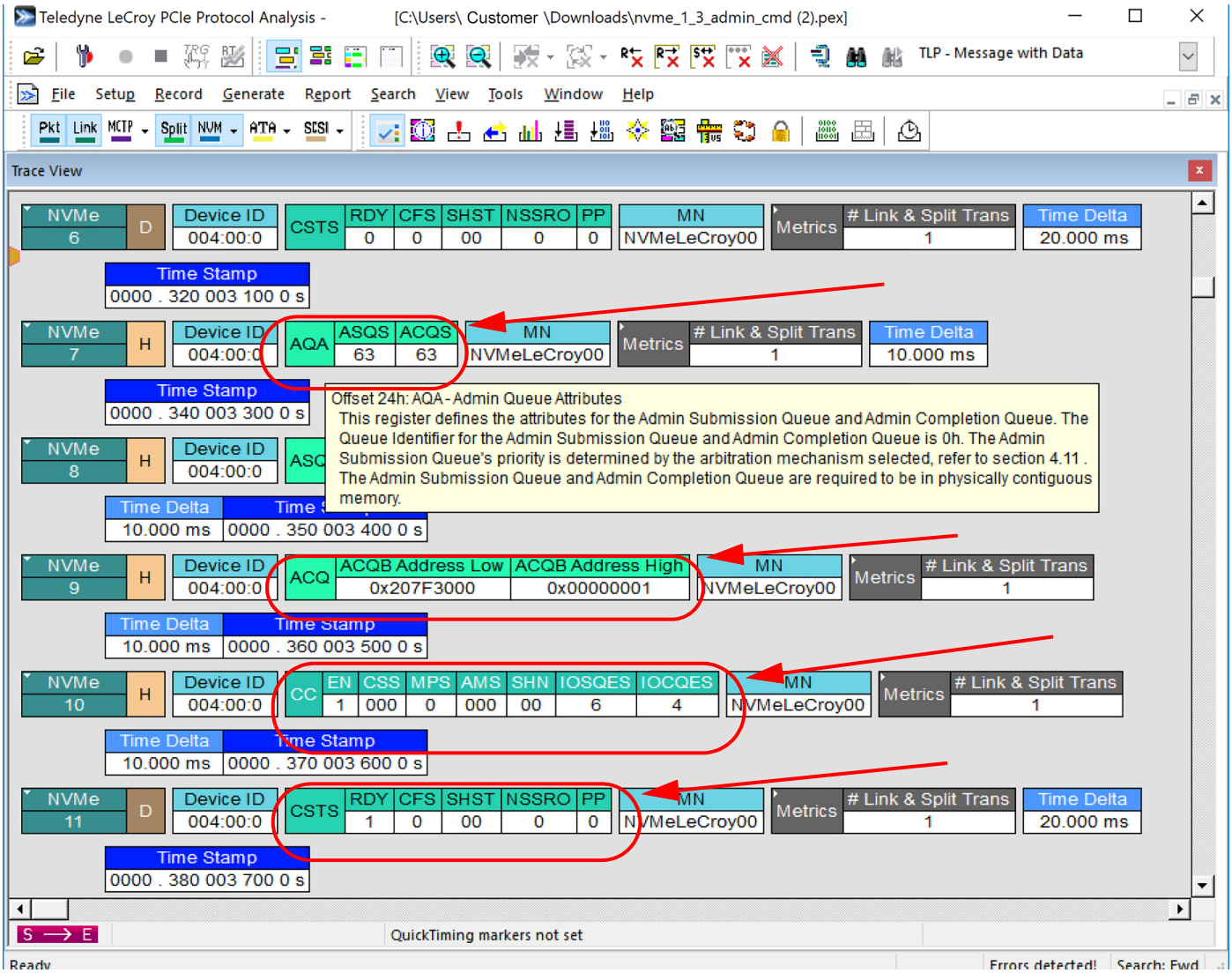


Figure 6.122: NVMe 1.3c Spec: Decodes --> Admin Commands

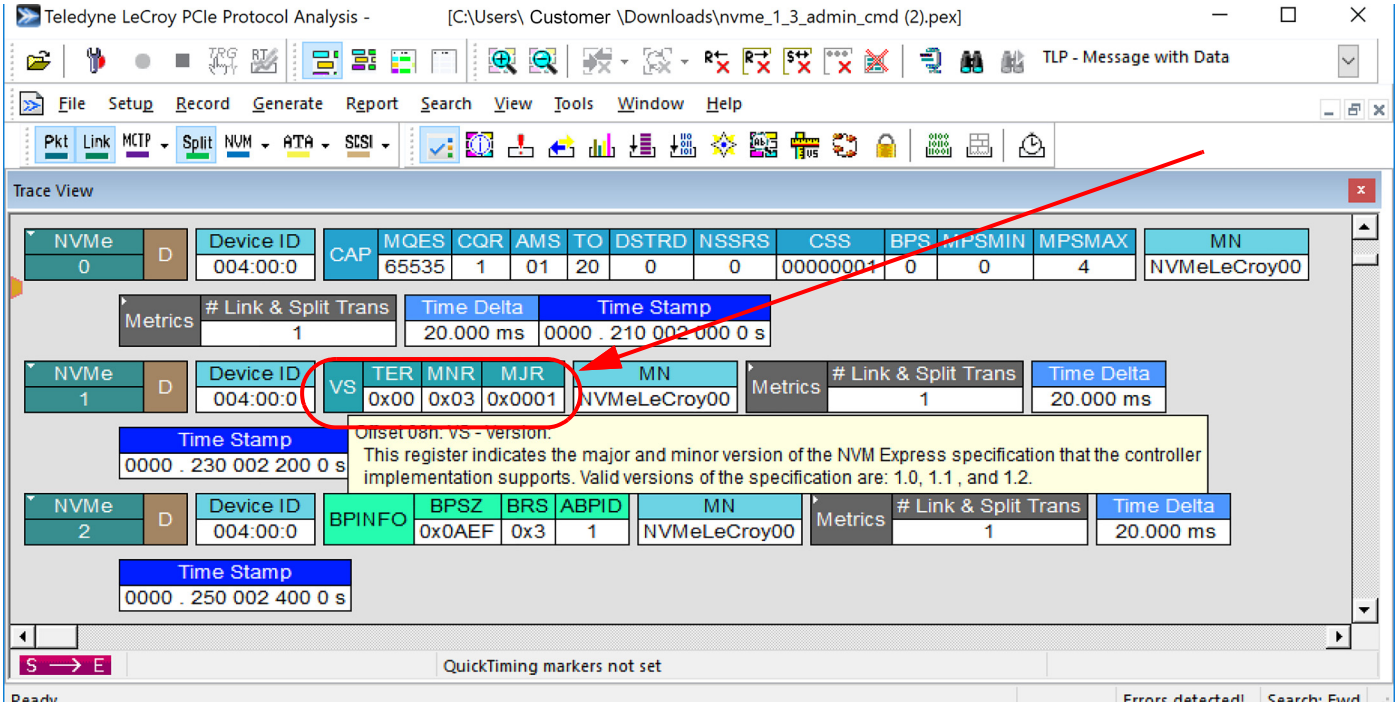


Figure 6.123: NVMe 1.3c Spec: Decodes --> Spec Version 1.3c

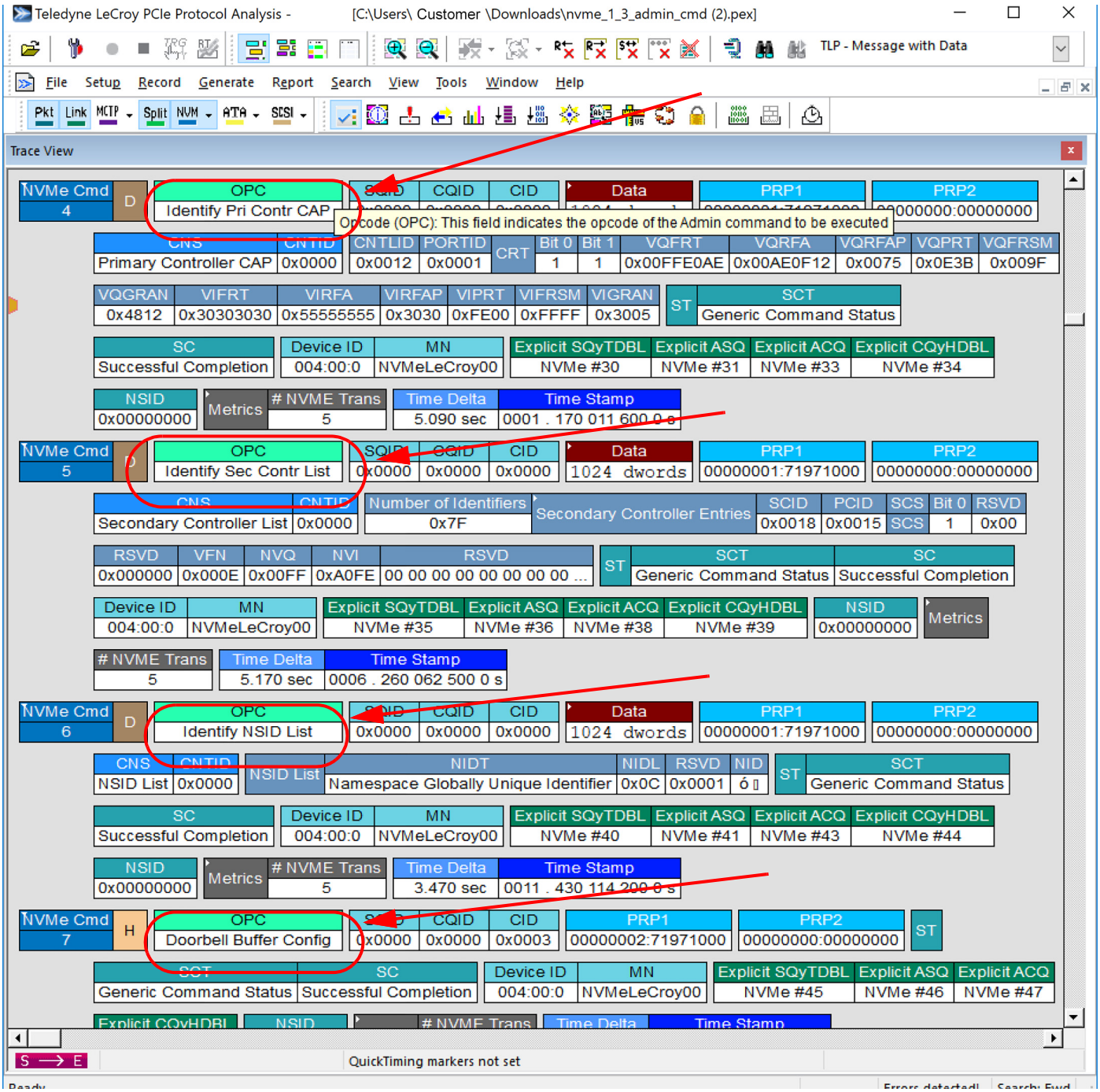


Figure 6.124: NVMe 1.3c Spec: Decodes --> Opcodes

6.11.22 NVMe Warning Messages

The PCIe Protocol Analysis software is capable of decoding the following NVMe Warning messages:

- Trace View
- Traffic Summary
- Search for NVMe Commands
- Search for NVMe Transactions
- Hiding Options

6.11.22.1 Trace View

If you decode for NVMe Commands and Transactions you'll see the following types of warning messages: See Figure 6.125, Figure 6.126 on page 488, Figure 6.127 on page 488 and Figure 6.128 on page 488.

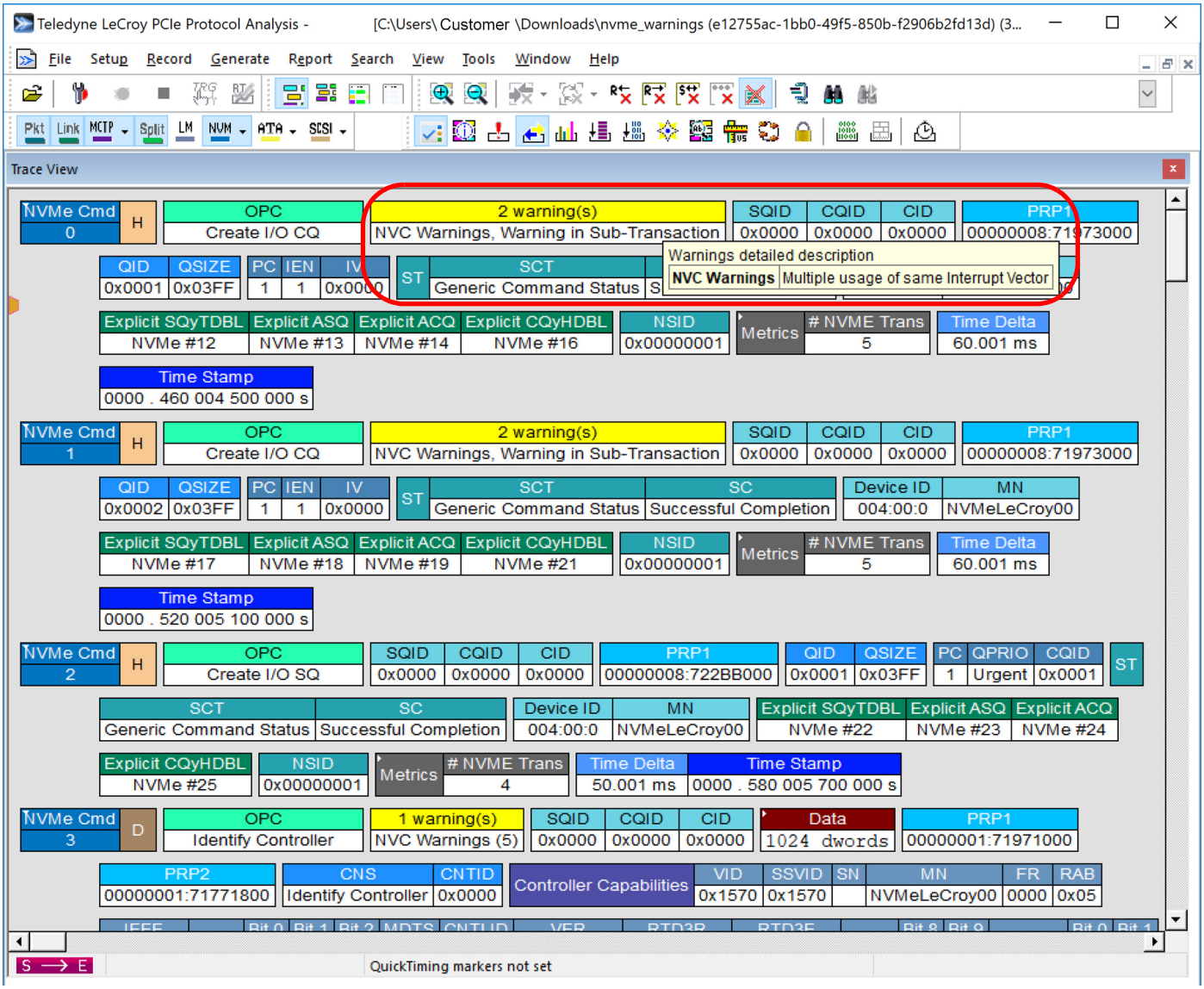


Figure 6.125: NVMe Command: Warning Message 1

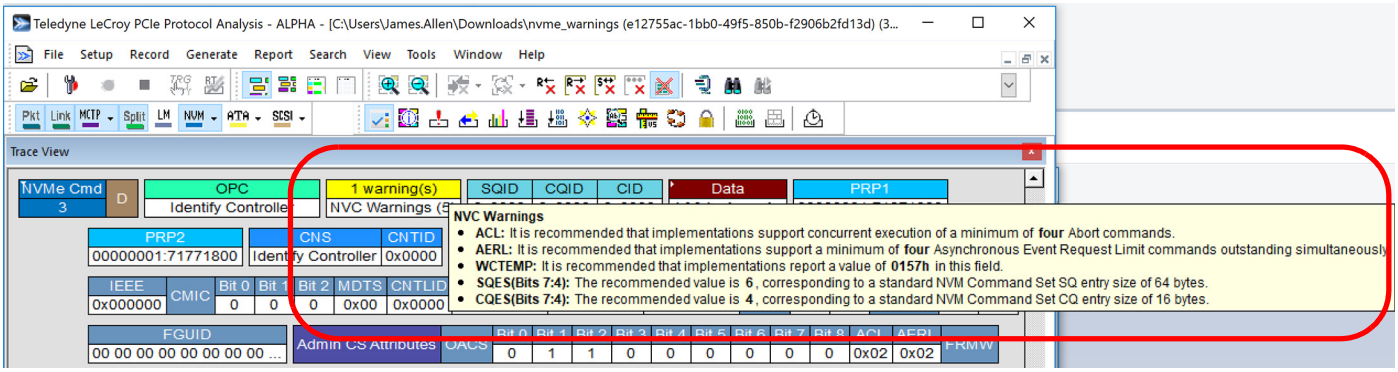


Figure 6.126: NVMe Command: Warning Message 2

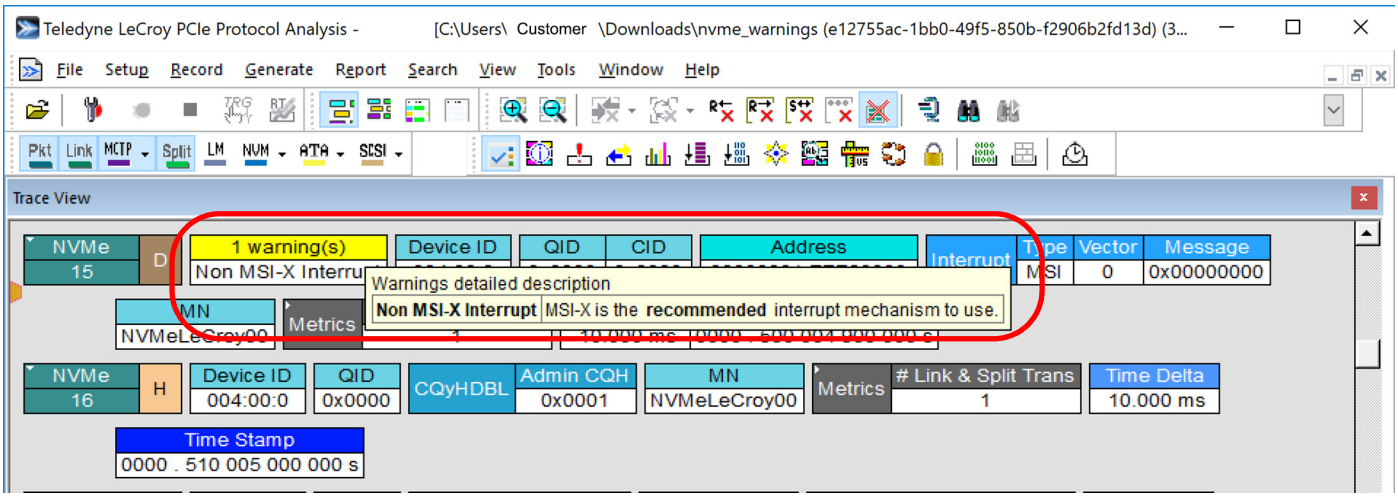


Figure 6.127: NVMe Transaction: Warning Message

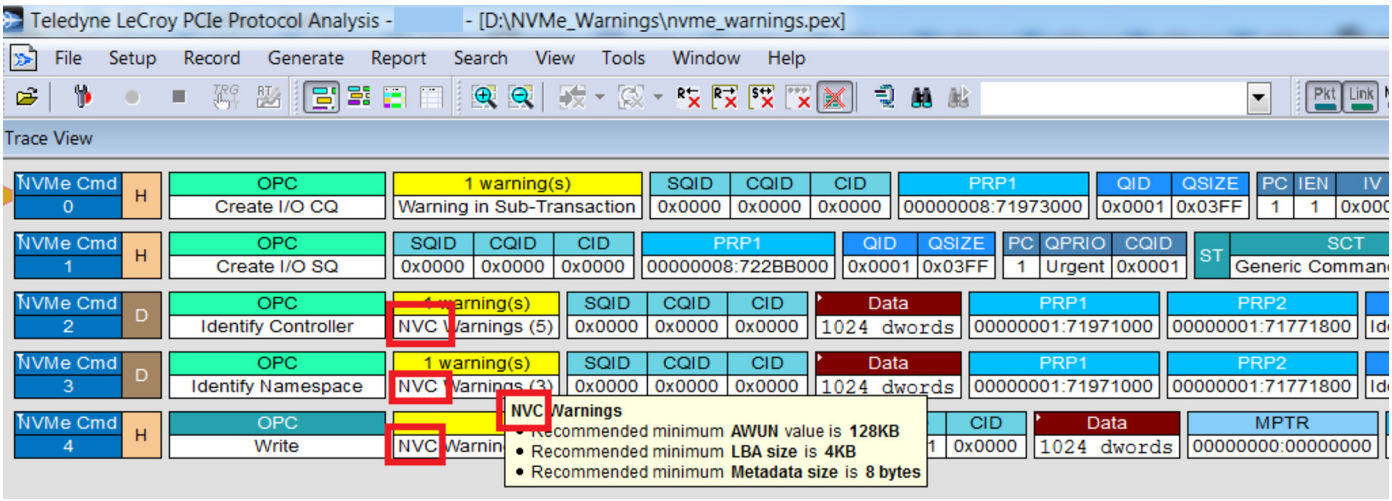


Figure 6.128: NVC Warning in NVMe Command Transaction

6.11.22.2 Traffic Summary View

The NVMe Warning Messages can be seen in the Traffic Summary Reports (see Figure 6.130, Figure 6.131 on page 491, Figure 6.132 on page 492 and Figure 6.132 on page 492) below:

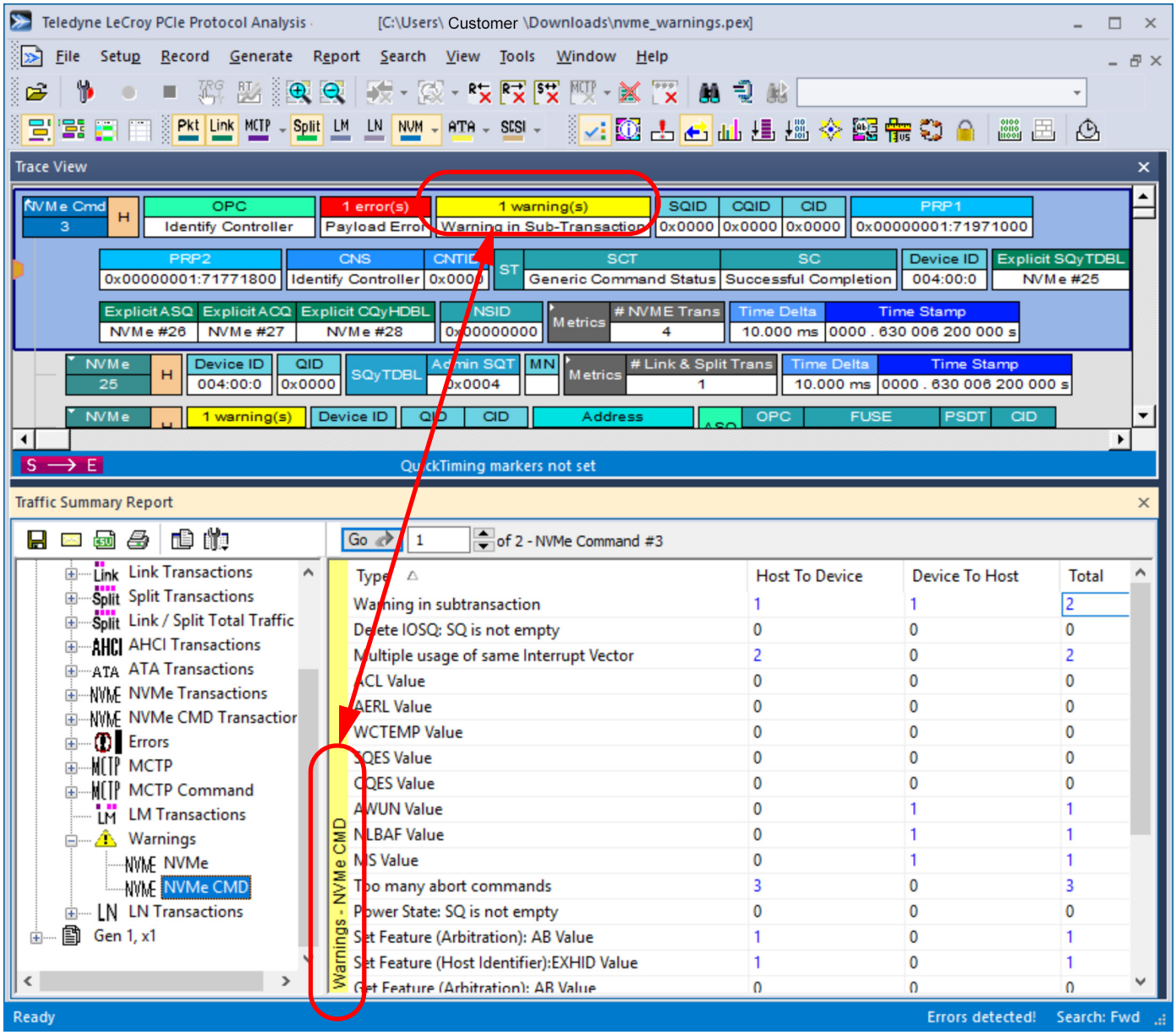


Figure 6.129: Warnings: NVMe CMD

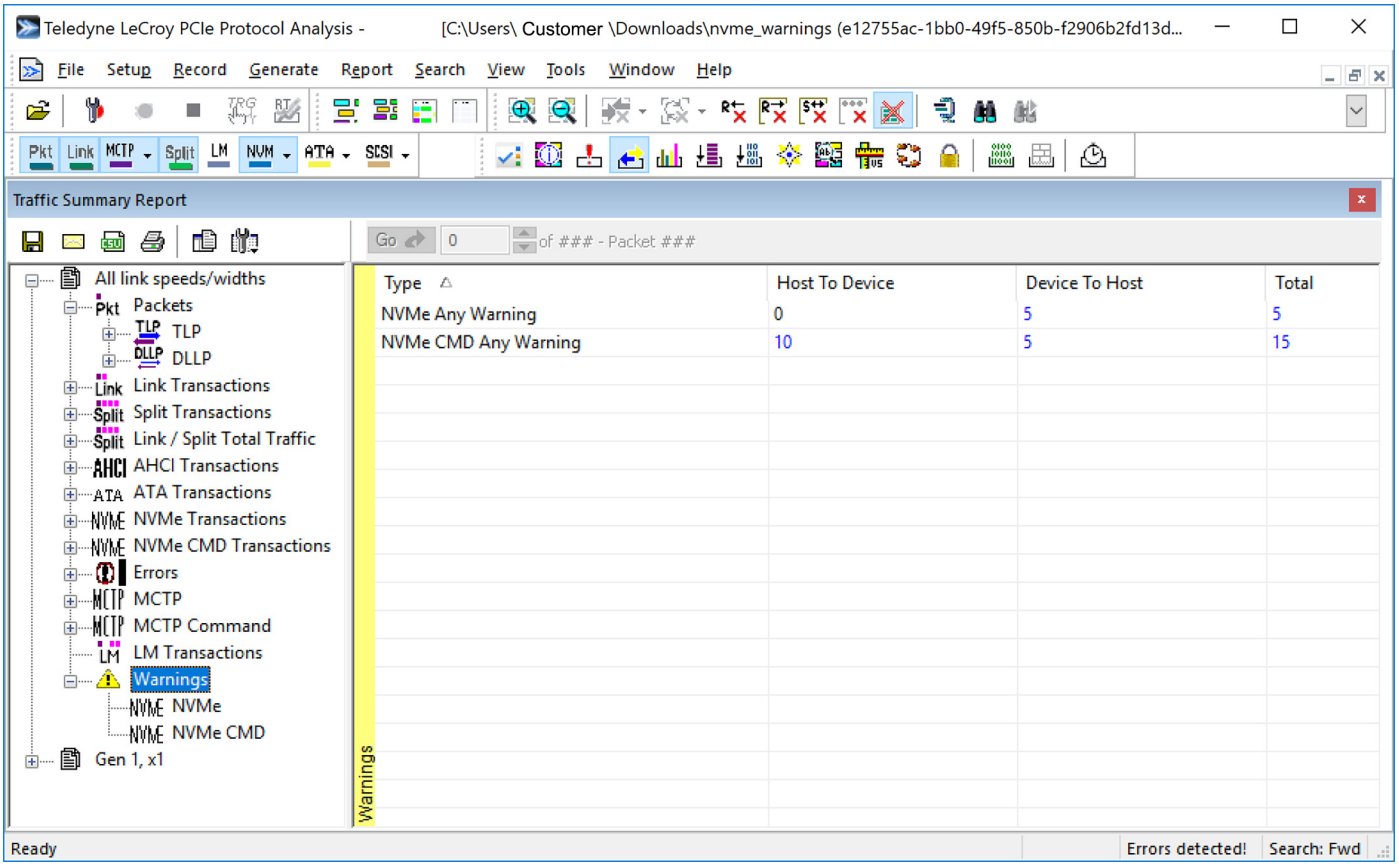


Figure 6.130: NVMe Warning Messages: Traffic Summary

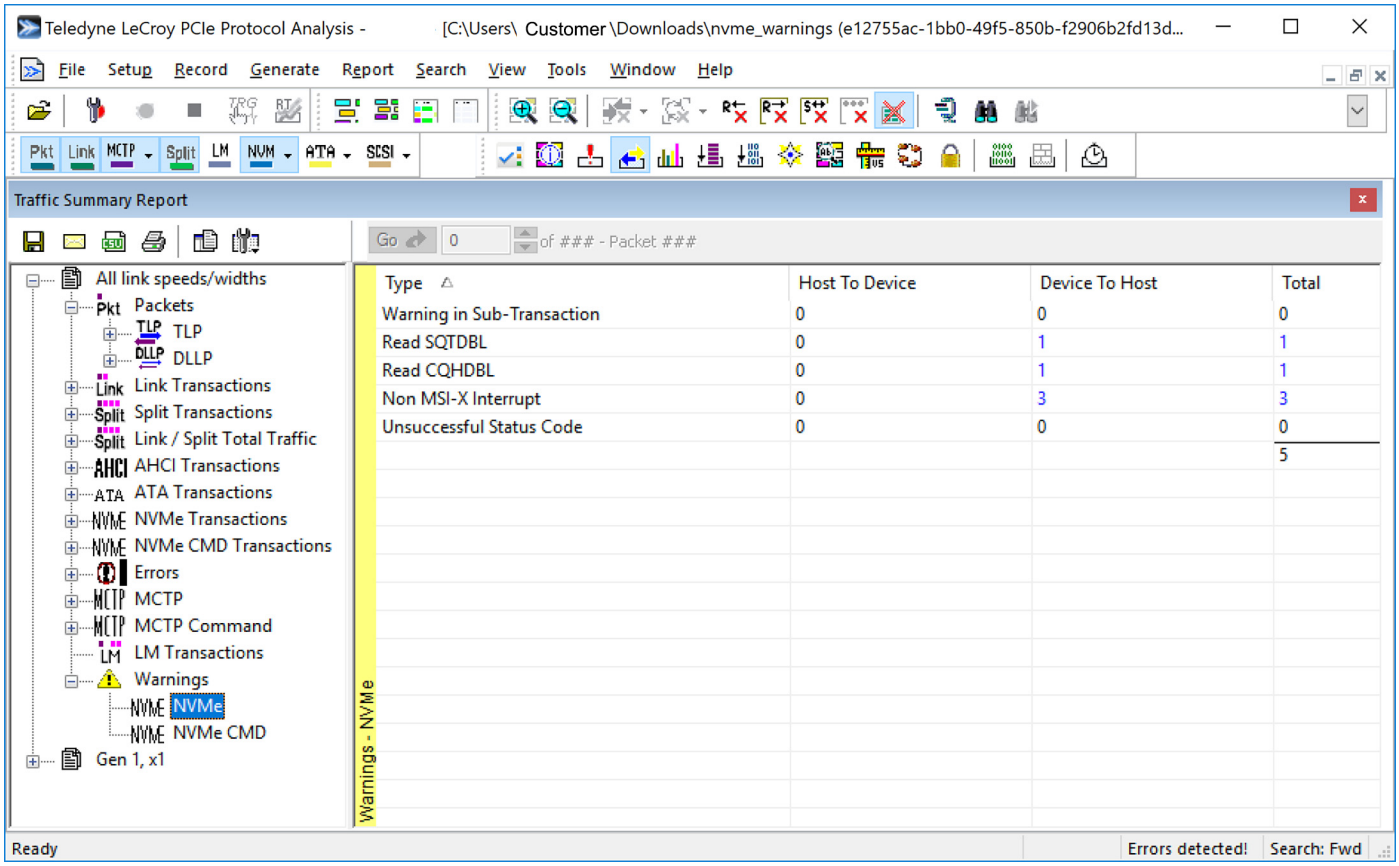
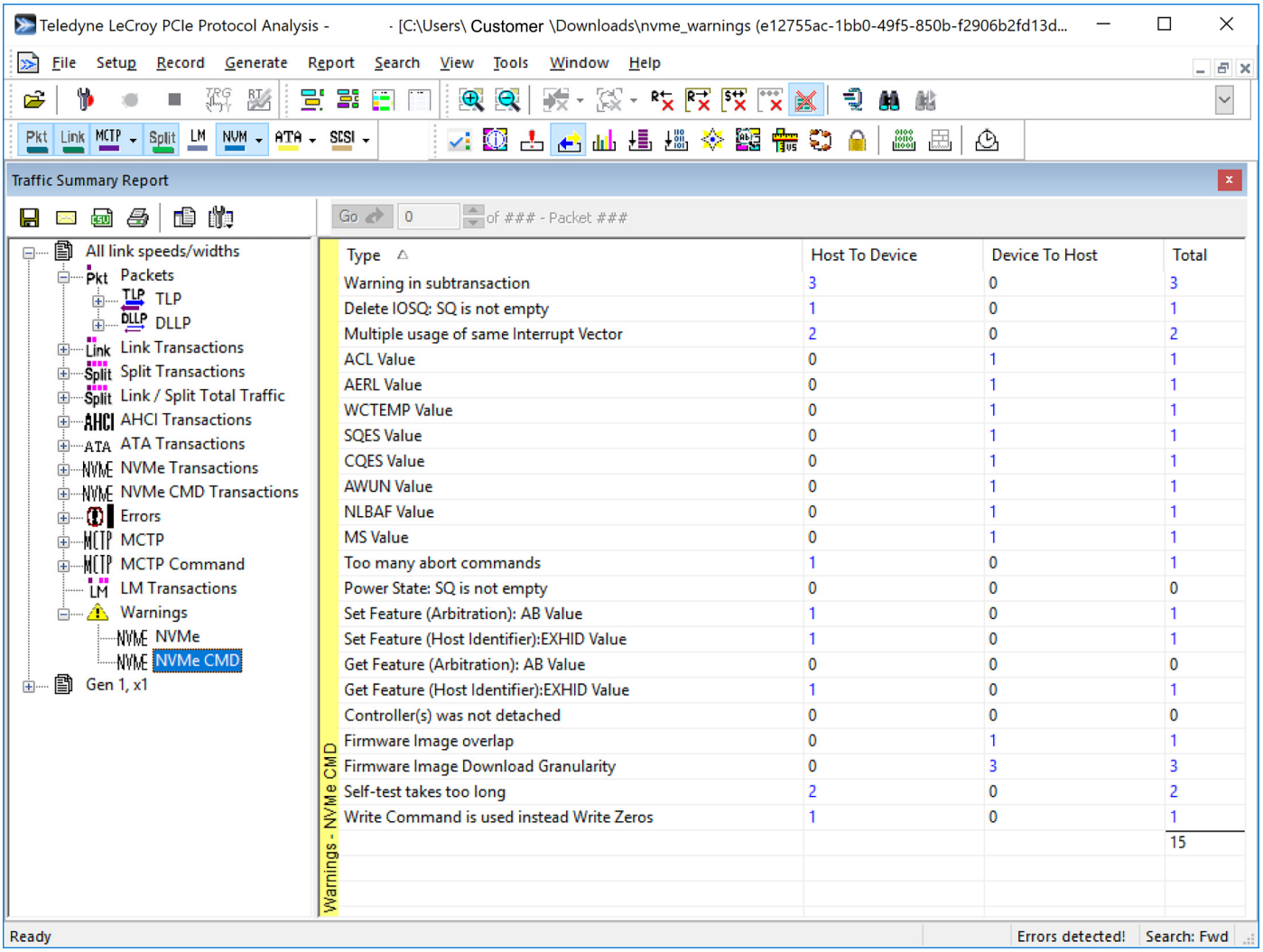


Figure 6.131: NVMe Warning Messages: Traffic Summary NVMe



Type	Host To Device	Device To Host	Total
Warning in subtransaction	3	0	3
Delete IOSQ: SQ is not empty	1	0	1
Multiple usage of same Interrupt Vector	2	0	2
ACL Value	0	1	1
AERL Value	0	1	1
WCTEMP Value	0	1	1
SQES Value	0	1	1
CQES Value	0	1	1
AWUN Value	0	1	1
NLBAF Value	0	1	1
MS Value	0	1	1
Too many abort commands	1	0	1
Power State: SQ is not empty	0	0	0
Set Feature (Arbitration): AB Value	1	0	1
Set Feature (Host Identifier):EXHID Value	1	0	1
Get Feature (Arbitration): AB Value	0	0	0
Get Feature (Host Identifier):EXHID Value	1	0	1
Controller(s) was not detached	0	0	0
Firmware Image overlap	0	1	1
Firmware Image Download Granularity	0	3	3
Self-test takes too long	2	0	2
Write Command is used instead Write Zeros	1	0	1
			15

Figure 6.132: NVMe Warning Messages: Traffic Summary NVMe CMD

6.11.22.3 Find NVMe Commands and Transactions

You can use the "Find" function to display the NVMe Commands and Transactions Warning Messages. See Figure 6.133 on page 493 and Figure 6.134 on page 494.

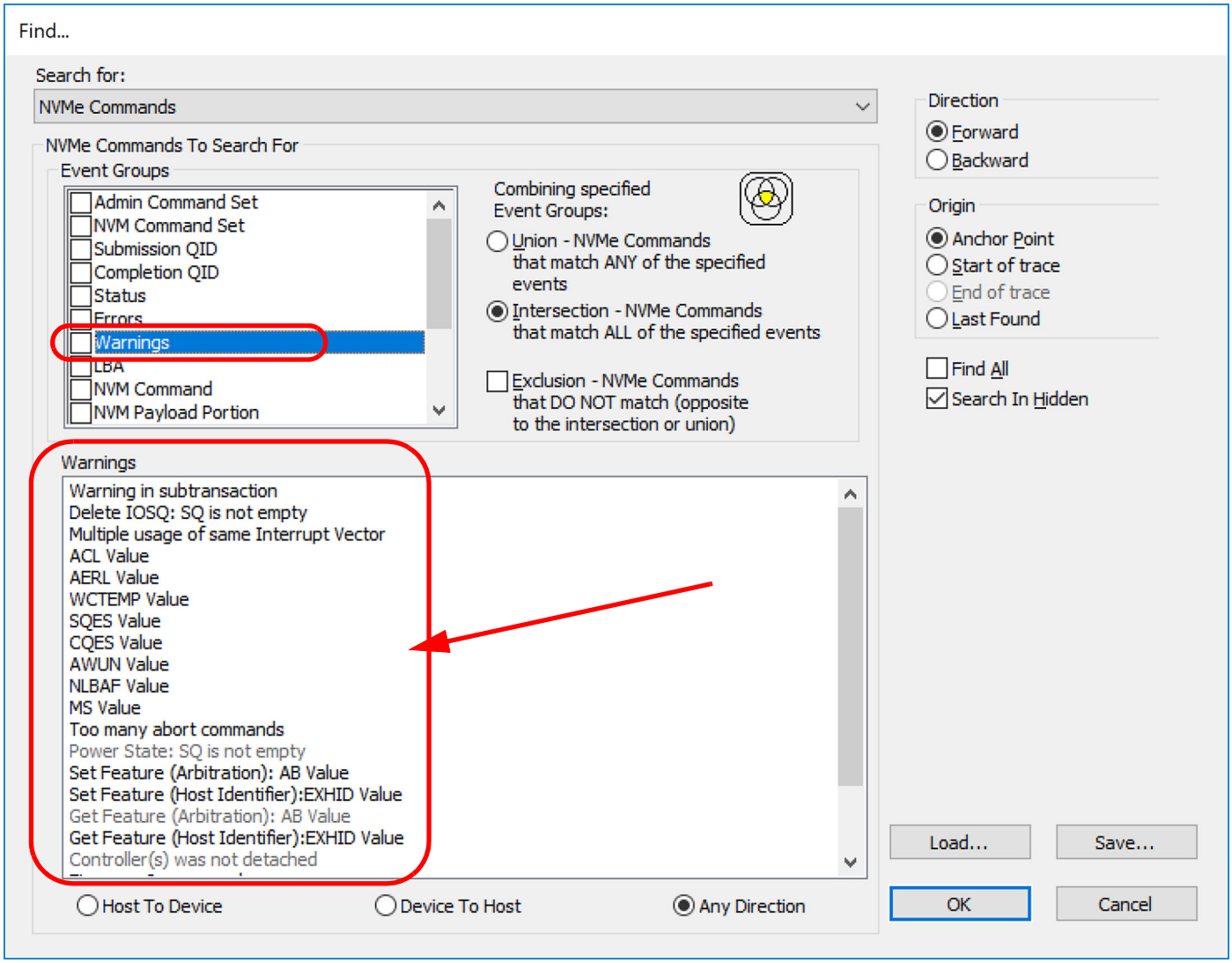


Figure 6.133: Find: NVMe Commands -> Warning Messages

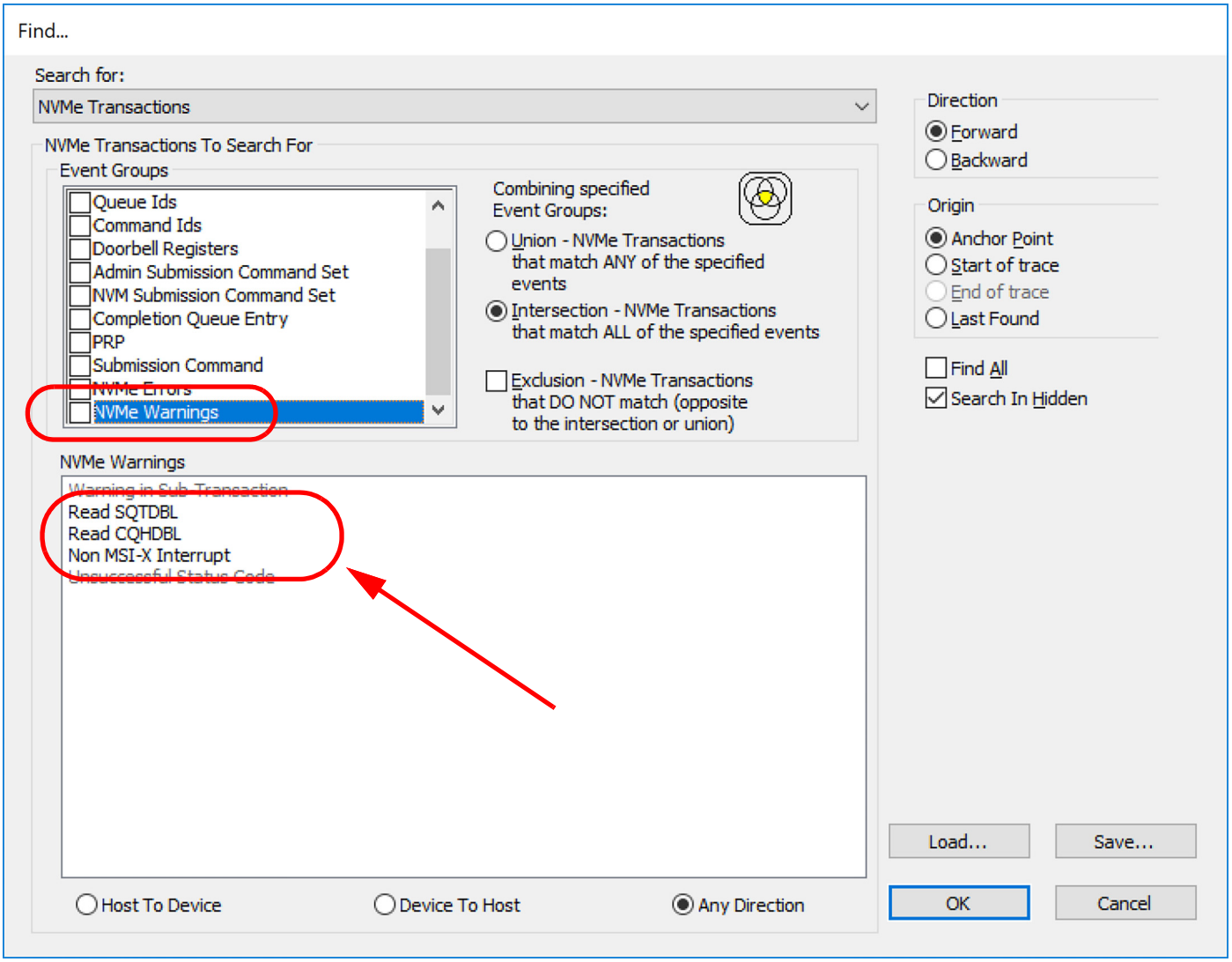


Figure 6.134: Find: NVMe Transactions -> Warning Messages

6.11.22.4 Hiding NVMe Warning Messages

You can also Hide  NVMe Warning Messages to remove them from the traffic. See Figure 6.135 on page 495.

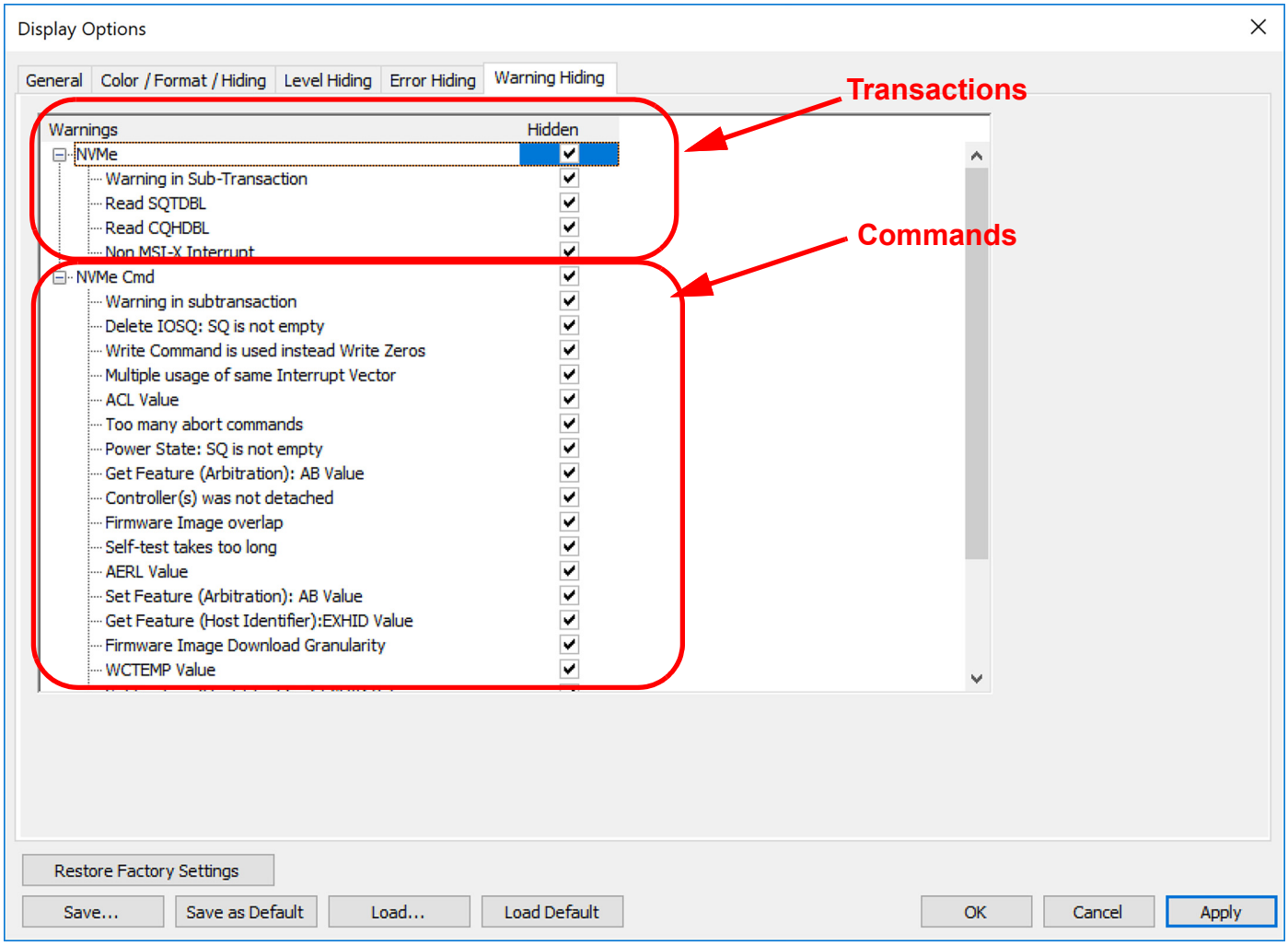


Figure 6.135: Hide -> NVMe Warning Messages

6.11.23 Decoding Lightweight Notification (LN) Protocol

The Lightweight Notification Protocol extension would allow co-processors or peripheral chips to talk to each other through system memory using a PCIe transaction without interrupting a host processor. For example, an Ethernet switch could respond to commands to encrypt and decrypt specific data packets while a host processor is inactive.

The PCIe Protocol Analysis software supports the decoding of Gen4 1.0 Lightweight Notification (LN) Protocol as shown in Figure 6.136 as well as the Traffic Summary Report.

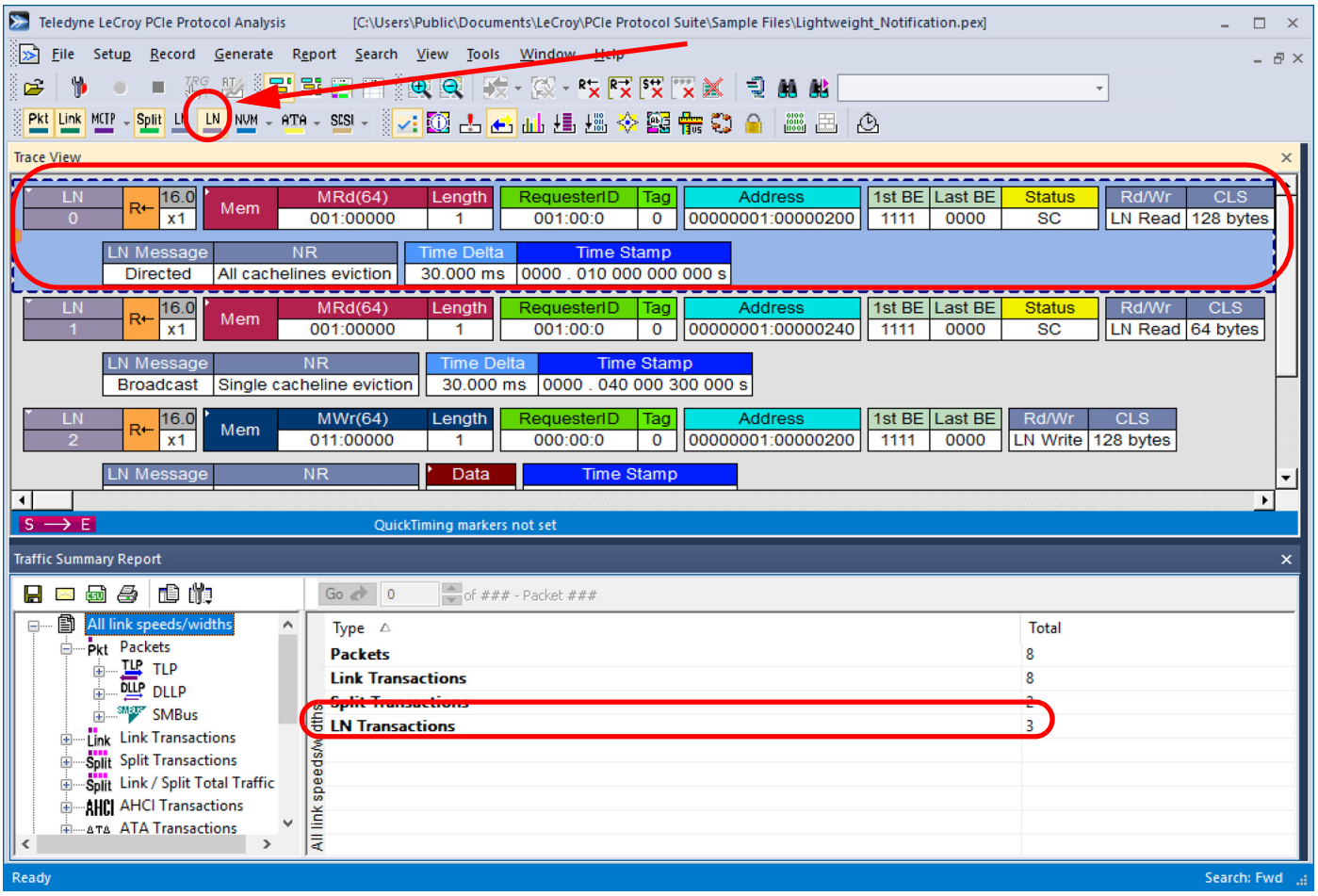


Figure 6.136: Decoding Lightweight Notification (LN) Protocol

6.11.23.1 Lightweight Notification Protocol Errors

The PCIe Protocol Analysis software also decodes any errors in the LN protocol. See Figure 6.137

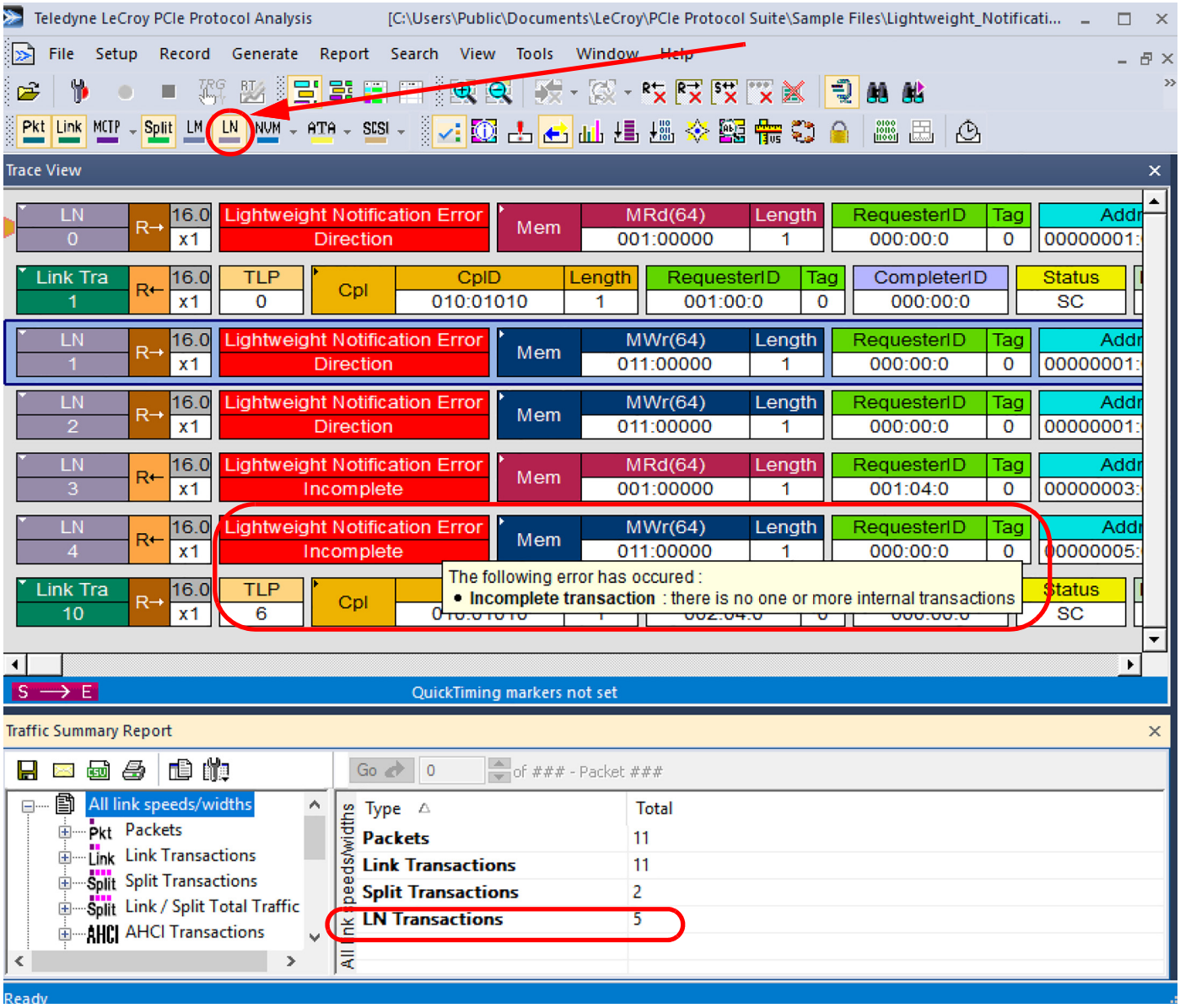


Figure 6.137: Decoding Errors in Lightweight Notification Protocol

6.11.23.2 Lightweight Notification Protocol in Trace Expert

The LN Protocol is also shown in the Trace Expert View (see Figure 6.138).

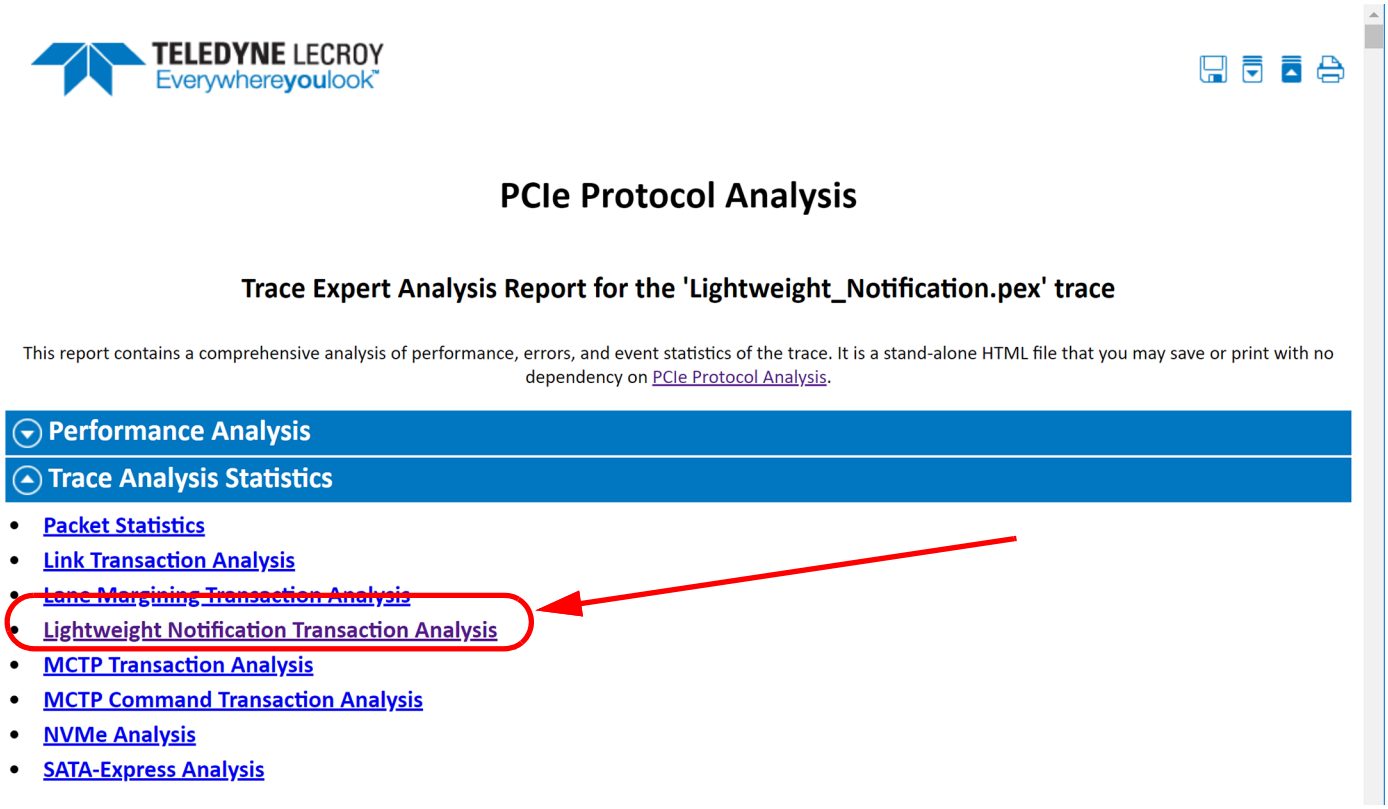
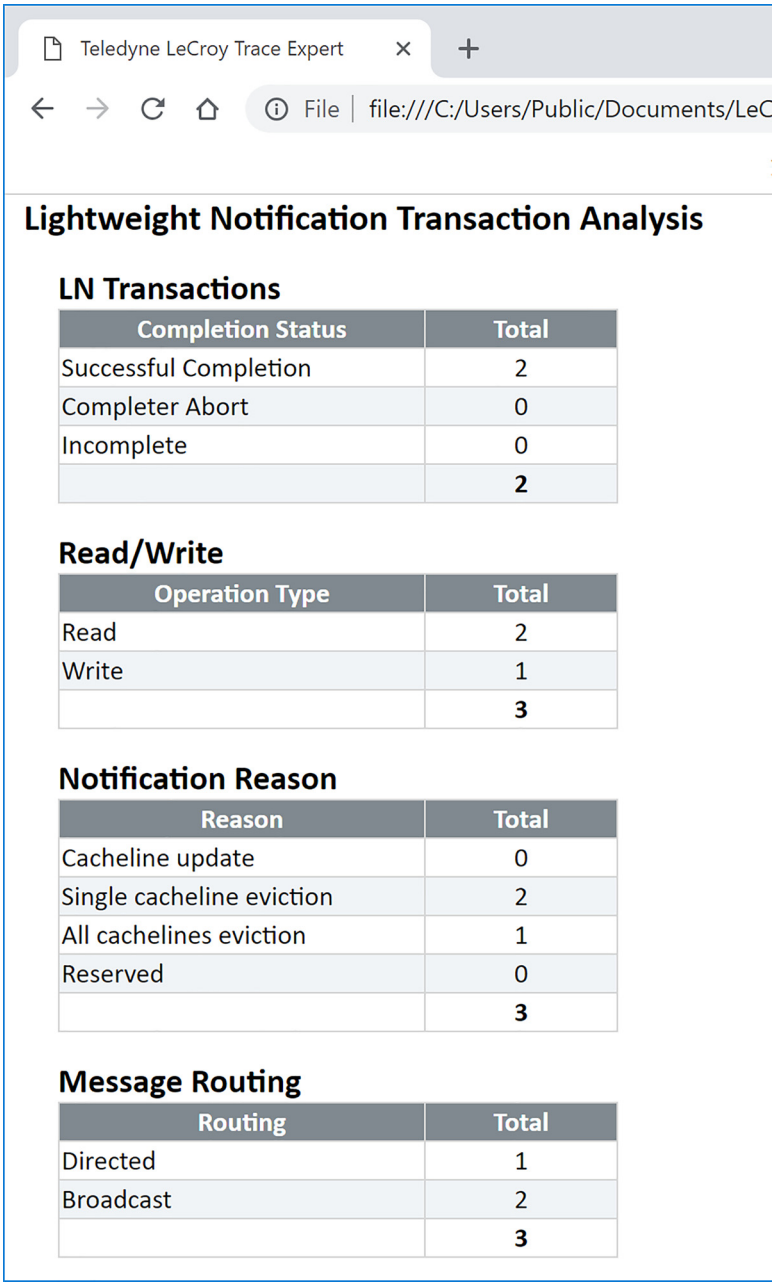


Figure 6.138: Lightweight Notification Transaction Analysis

The details of that LN Transaction Analysis can be seen in Figure 6.139 on page 499.



Lightweight Notification Transaction Analysis

LN Transactions

Completion Status	Total
Successful Completion	2
Completer Abort	0
Incomplete	0
	2

Read/Write

Operation Type	Total
Read	2
Write	1
	3

Notification Reason

Reason	Total
Cacheline update	0
Single cacheline eviction	2
All cachelines eviction	1
Reserved	0
	3

Message Routing

Routing	Total
Directed	1
Broadcast	2
	3

Figure 6.139: LN Transaction Analysis

6.11.23.3 Lightweight Notification Transaction Analysis Errors: Trace Expert

Lightweight Notification Transaction Analysis Errors can also be seen in Trace Expert. See Figure 6.140.

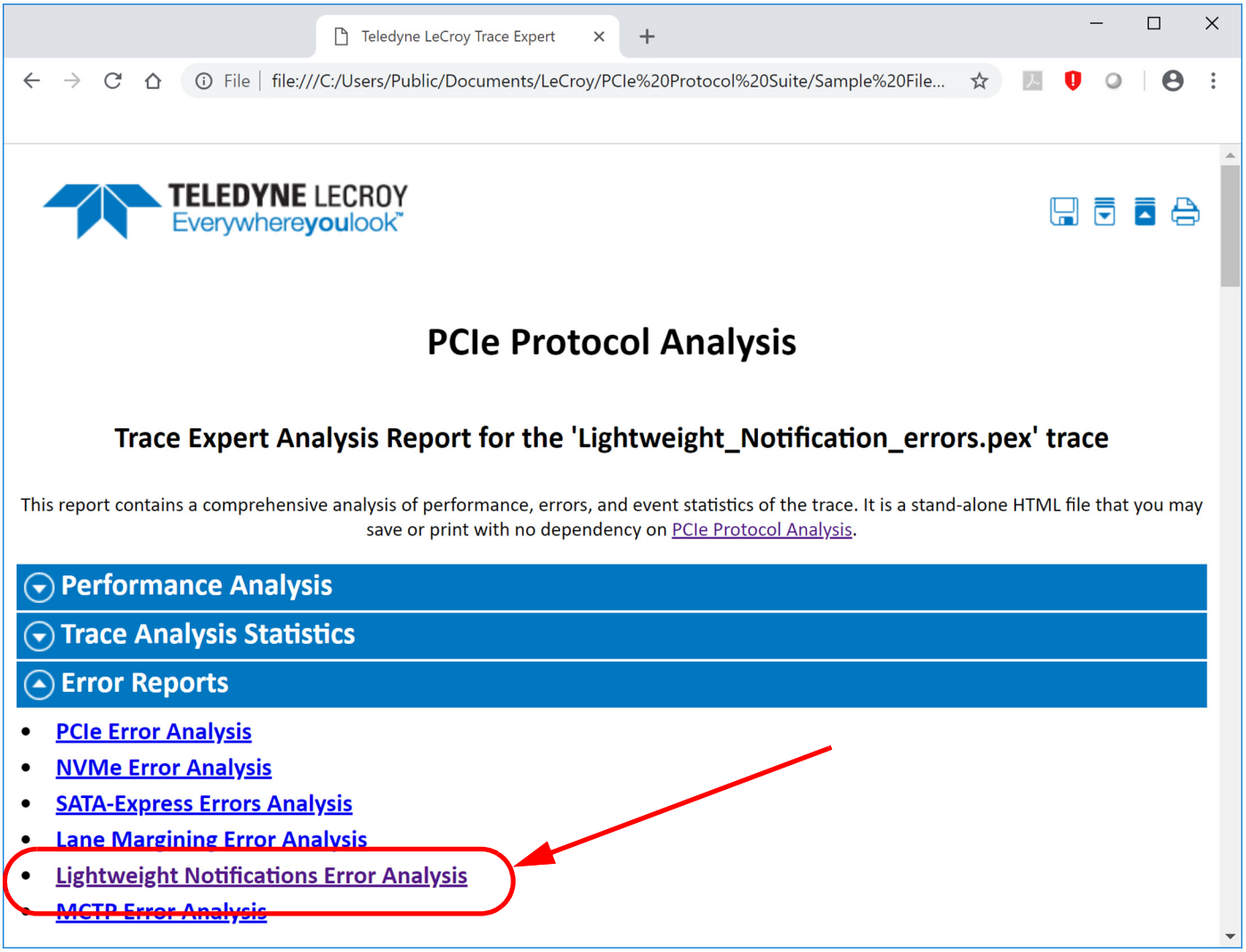


Figure 6.140: Trace Expert: Lightweight Notification Transaction Analysis Errors

Those errors can be seen in detail in Trace Expert (see Figure 6.141 on page 501).

Lightweight Notifications Error Analysis

Lightweight Notifications Errors

Error	Total
Incomplete Transaction	2
Wrong Read/Write Direction	3
Wrong Message Direction	1
Any Error	5

Figure 6.141: Lightweight Notification Errors from Trace Expert

6.11.23.4 Find: Lightweight Notification Transactions

You can use the Find tool to locate Lightweight Notification transactions. See Figure 6.142.

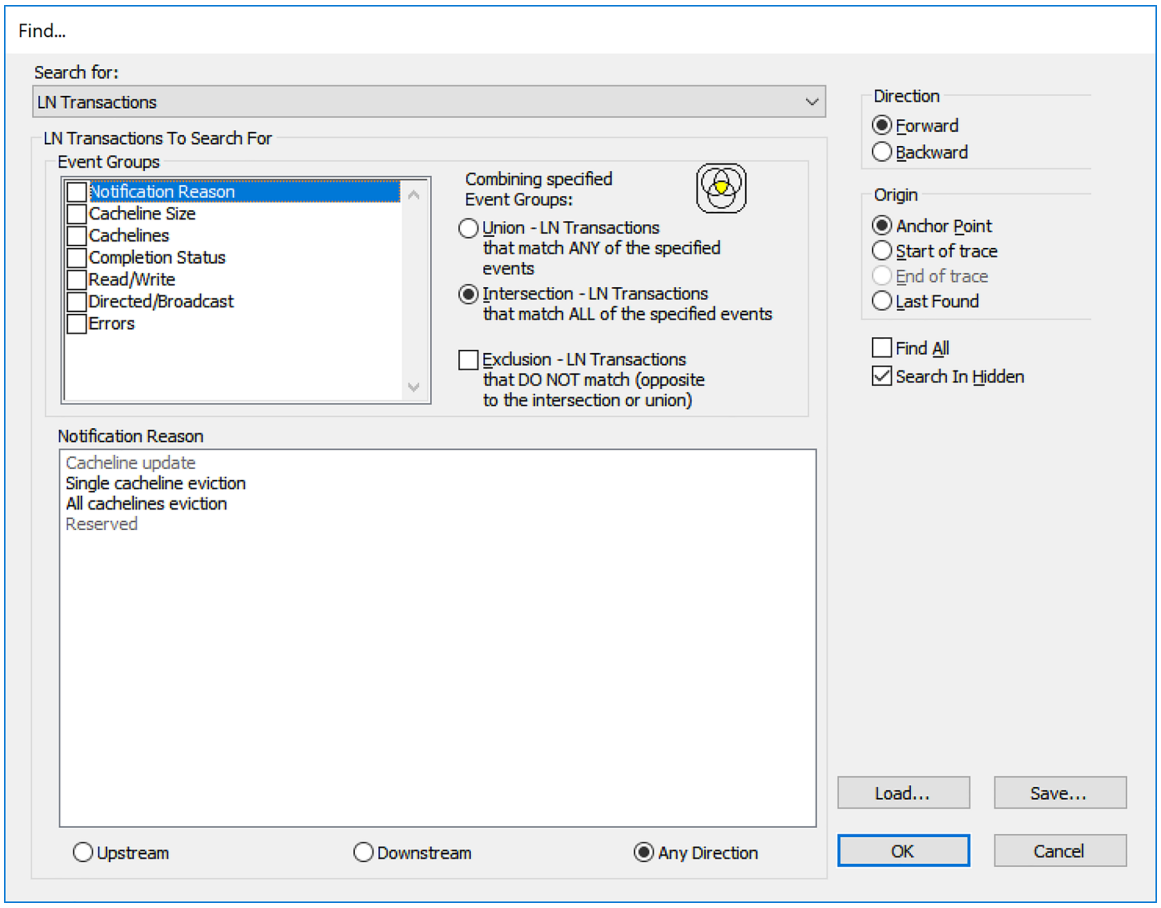


Figure 6.142: Lightweight Notification transactions

6.11.24 Decoding CCIX Protocol

PCIe Protocol Analysis software can decode the Cache Coherent Interconnect for Accelerators (CCIX) transaction protocol.

CCIX is a high-performance, low latency, chip-to-chip interconnect architecture that provides a cache coherent framework for heterogeneous system architectures. Cache coherency is automatically maintained at all time between the central processing unit and the various other accelerators in the system. Operating over standard PCIe, CCIX supports signaling rates between 16 GT/s and 25 GT/s per link with support for port aggregation for higher performance.

CCIX is largely an extension of the PCI Express architecture, consists of a number of stacked protocol layers.

- CCIX Protocol Layer - coherency protocol that manages memory reads and writes, provides a mapping for the on-chip architecture-dependent coherency protocols (e.g., AMBA CHI/ACE). This layer also defines the cache state (e.g. shared/unique, clean/dirty).
- CCIX Link Layer - formatting protocol for transport (e.g., PCIe). This layer also manages link aggregation.
- CCIX Transport Specification
- PCIe Transaction Layer - Handles PCIe transactions. The layer also supports virtual channels, permitting transmission for different data streams across a single shared link.
- CCIX Transaction Layer - Handles CCIX transactions. This layer optimizes out superfluous PCIe packet fields, reducing overhead.
- PCIe Data Link Layer - Handles standard data link layer (e.g., CRC, ACK).
- CCIX/PCIe Physical Layer - Handles standard PCIe physical layer. This layer also supports 25 GT/s ESM mode.

6.11.25 Decoding TCG Support of Pyrite

The PCIe Protocol Analysis software is capable of decoding Trusted Computing Group (TCG) Pyrite transactions. See Figure 6.143.

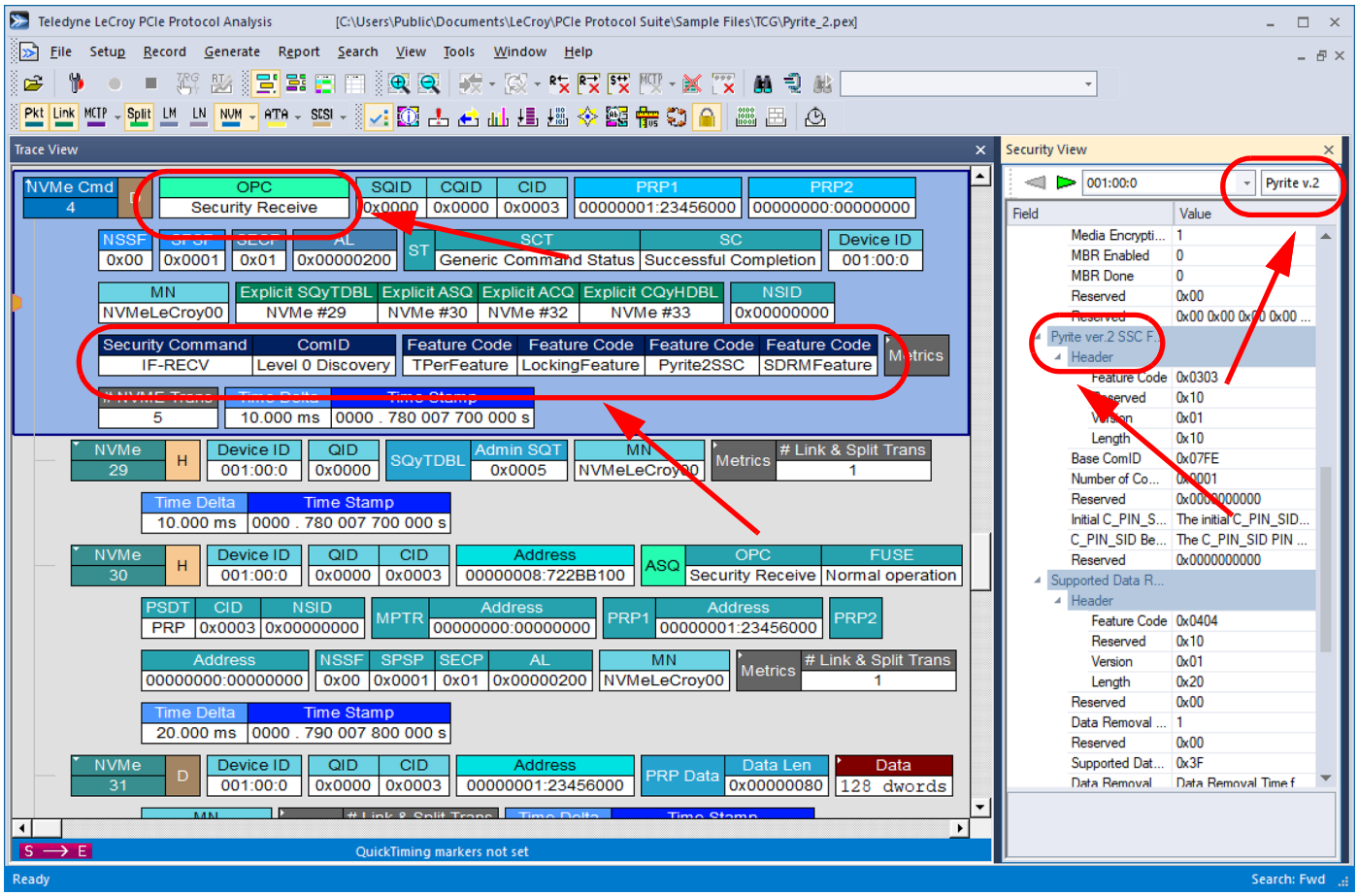


Figure 6.143: TCG Transactions: Decoded -> Pyrite

6.11.26 MCTP: Simple Hiding

You can hide (or filter out) either MCTP VDM traffic or SMBus MCTP traffic or both by using the MCTP Hide button on the toolbar. See Figure 6.144.

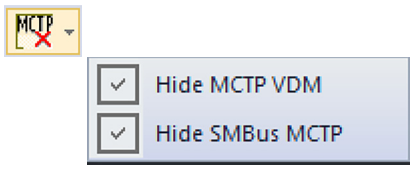


Figure 6.144: MCTP: Simple Hiding Icon

6.11.26.1 MCTP: Hide VDM Traffic

If you chose to hide only the MCTP VDM traffic a sample trace is shown below without the VDM traffic hidden (see Figure 6.145) and with VDM traffic hidden (see Figure 6.146 on page 505).

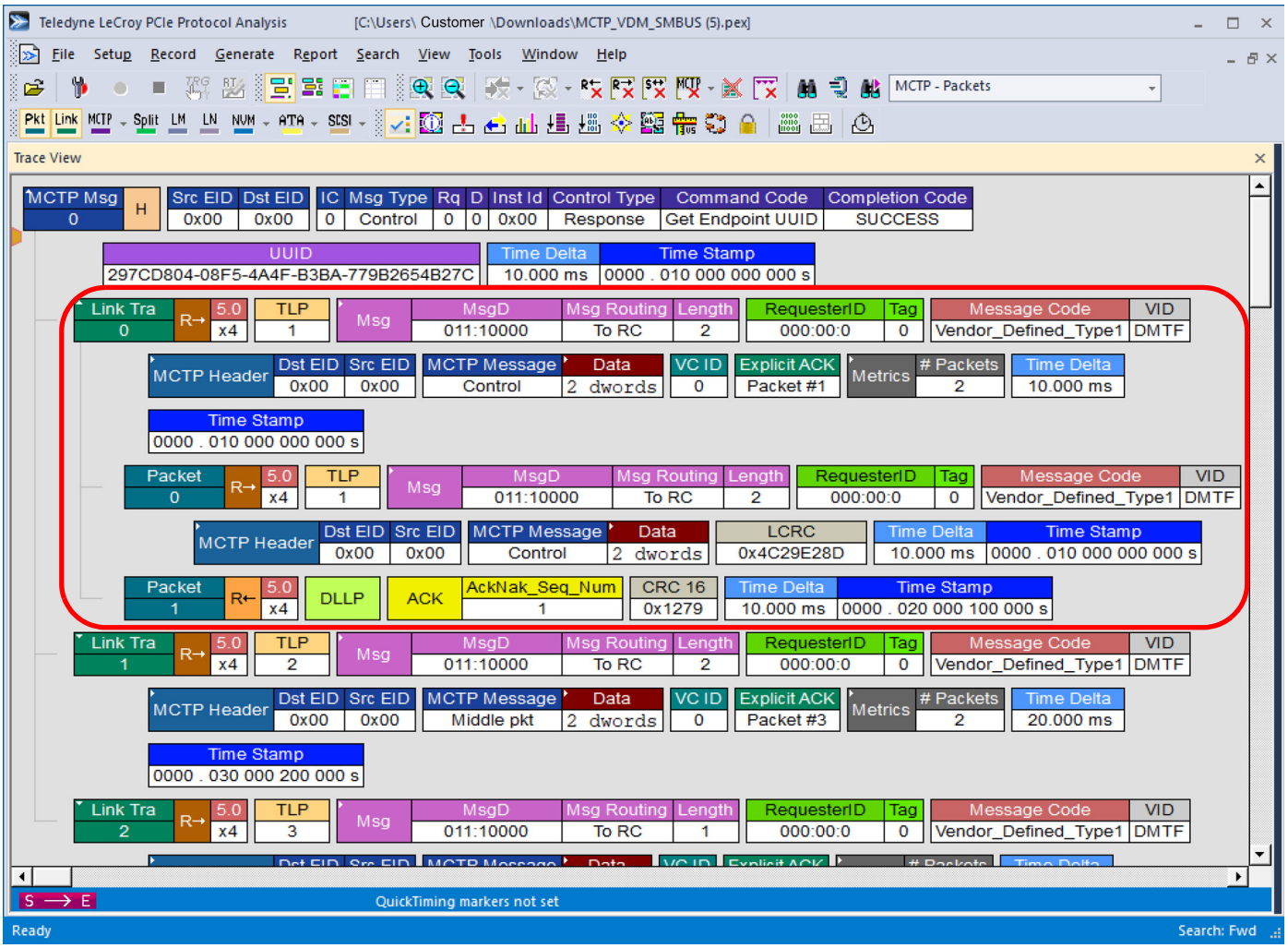


Figure 6.145: MCTP VDN Traffic: Link 0, Packet 0 -> Shown

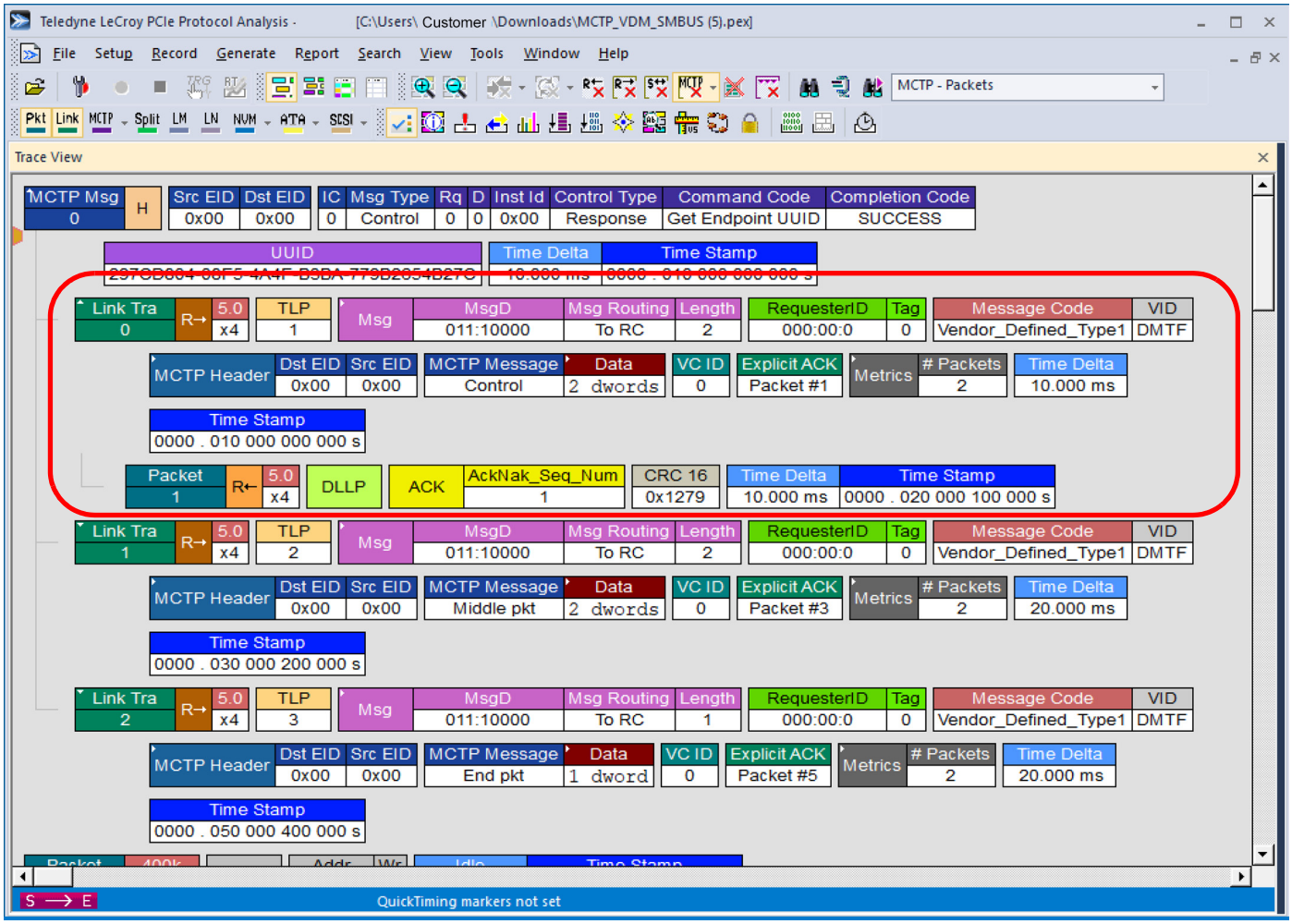


Figure 6.146: MCTP VDN Traffic: Link 0, Packet 0 -> Hidden

6.11.26.2 MCTP: Hide SMBus Traffic

If you chose to hide only the SMBus MCTP traffic a sample trace is shown below without the SMBus traffic hidden (see Figure 6.147) and with SMBus MCTP traffic hidden (see Figure 6.148 on page 507).

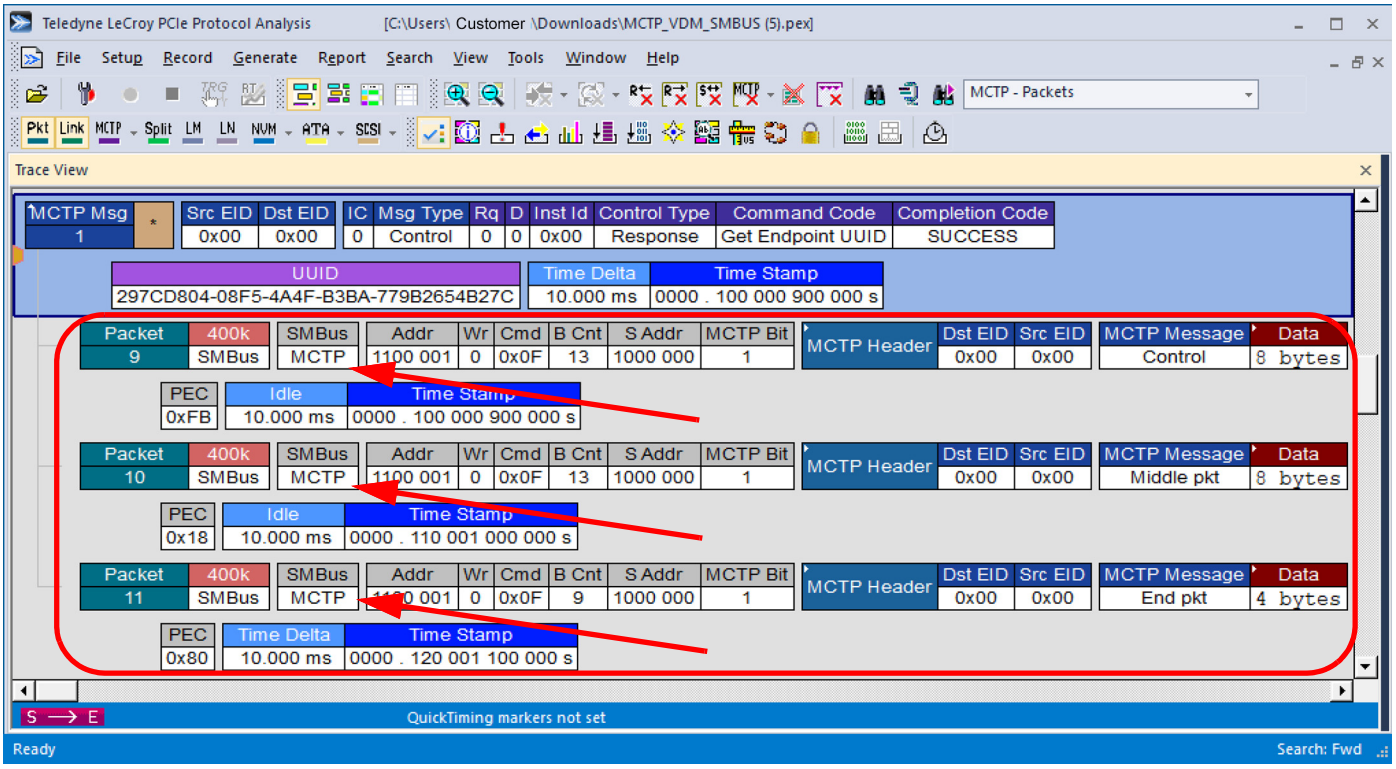


Figure 6.147: MCTP SMBus Traffic: Shown

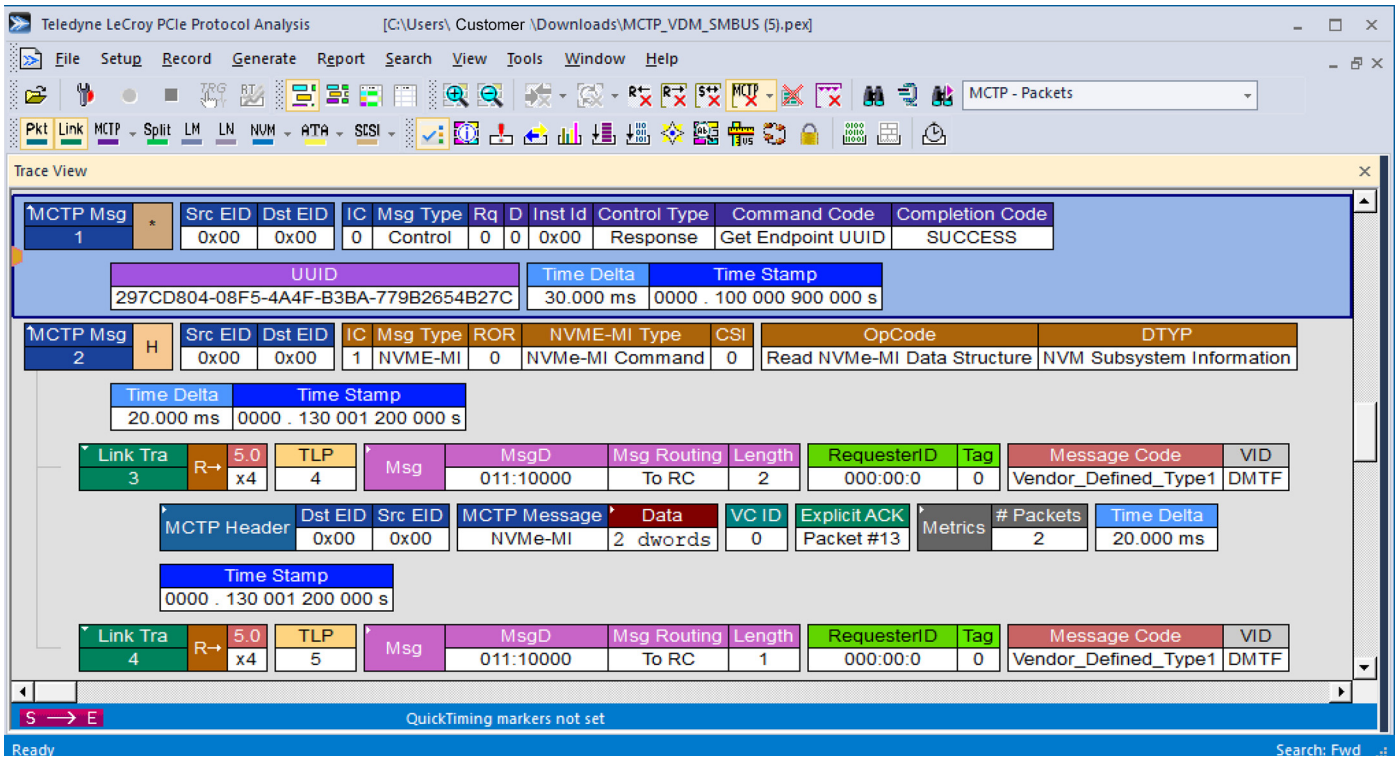


Figure 6.148: MCTP SMBus Traffic: Hidden

6.11.27 Decoding NVME-MI Version 1.1

The PCIe Protocol Analysis software can decode NVME-MI Version 1.1 traffic. See Figure 6.149.

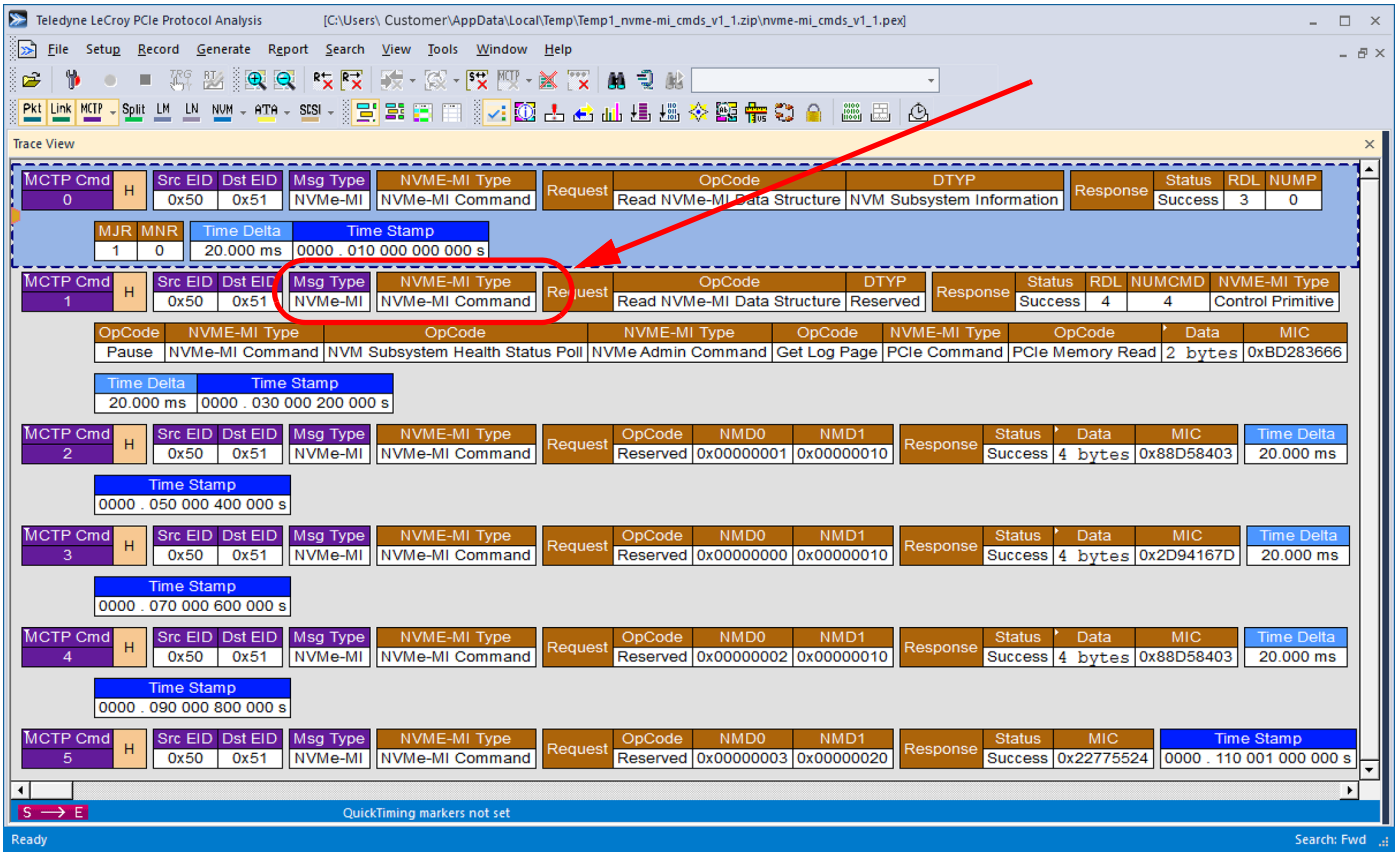


Figure 6.149: Decoding NVME-MI Version 1.1

6.11.28 Decoding NVME-MI Version 1.1 with BMC

The PCIe Protocol Analysis software can decode NVME-MI Version 1.1 with Basic Management Commands (BMC) traffic. See Figure 6.150.

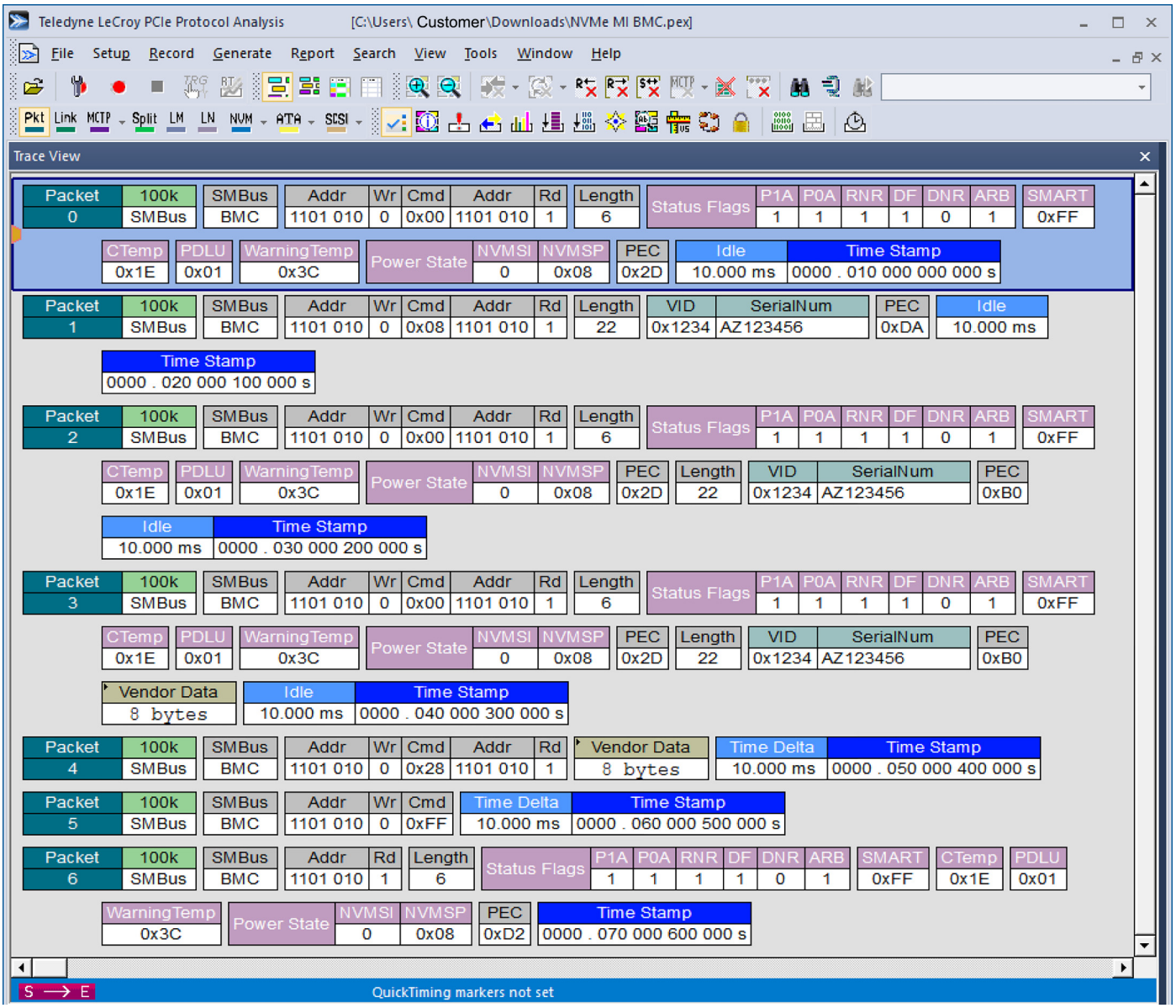


Figure 6.150: Decoding NVMe-MI BMC Traffic

6.11.28.1 NVMe-MI BMC Errors

The PCIe Protocol Analysis software can decode NVME-MI Version 1.1 with Basic Management Commands (BMC) traffic with errors. See Figure 6.151.

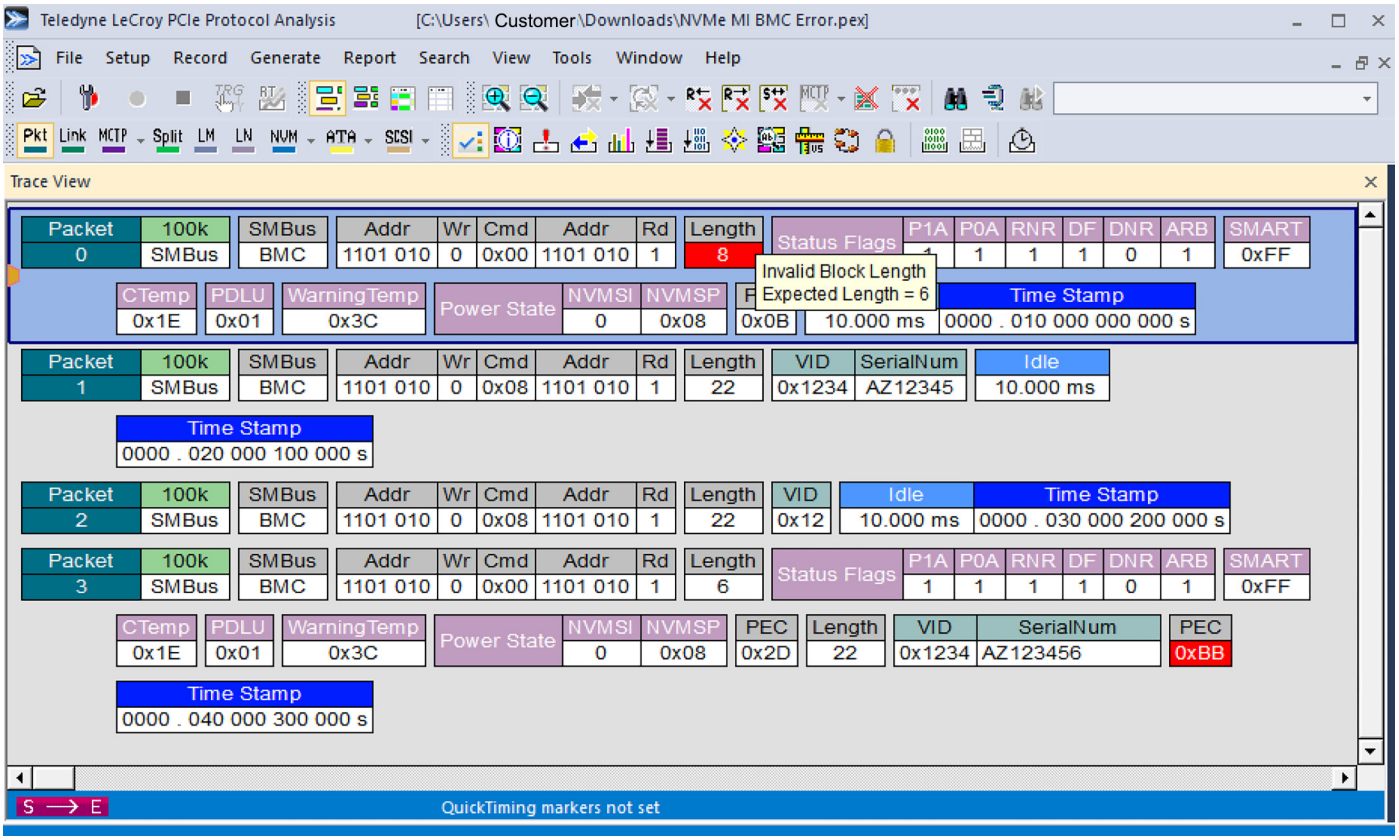


Figure 6.151: Decoding NVMe-MI BMC Errors

6.11.28.2 Errors Displayed in Traffic Summary

SMBus BMC errors also show up in the Traffic Summary View. See Figure 6.152

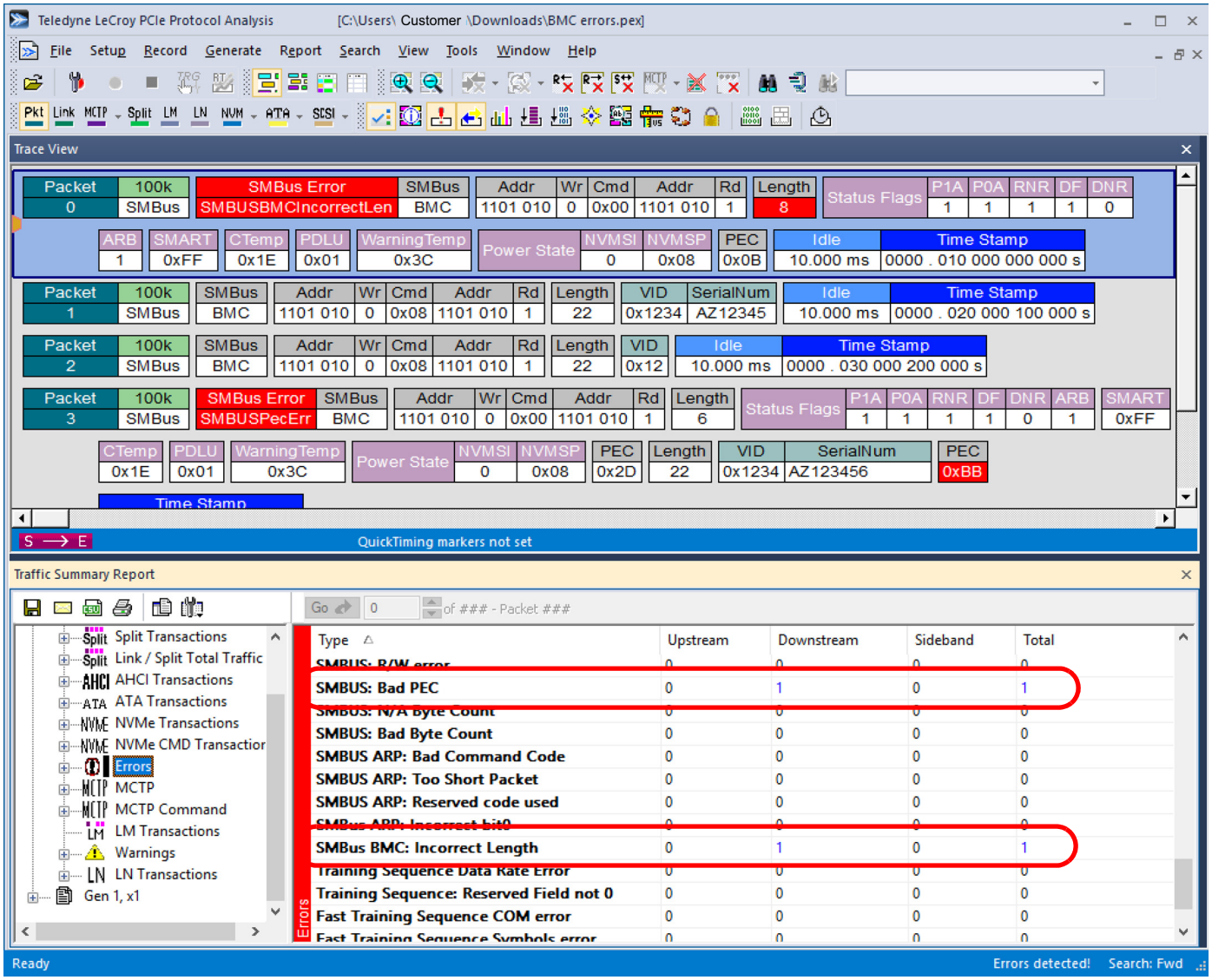


Figure 6.152: SMBus BMC Errors in Traffic Summary

6.11.28.3 Decoding BMC Commands with Any Offset

The PCIe Protocol Analysis can decode BMC Commands with any offset as shown below in Figure 6.153.

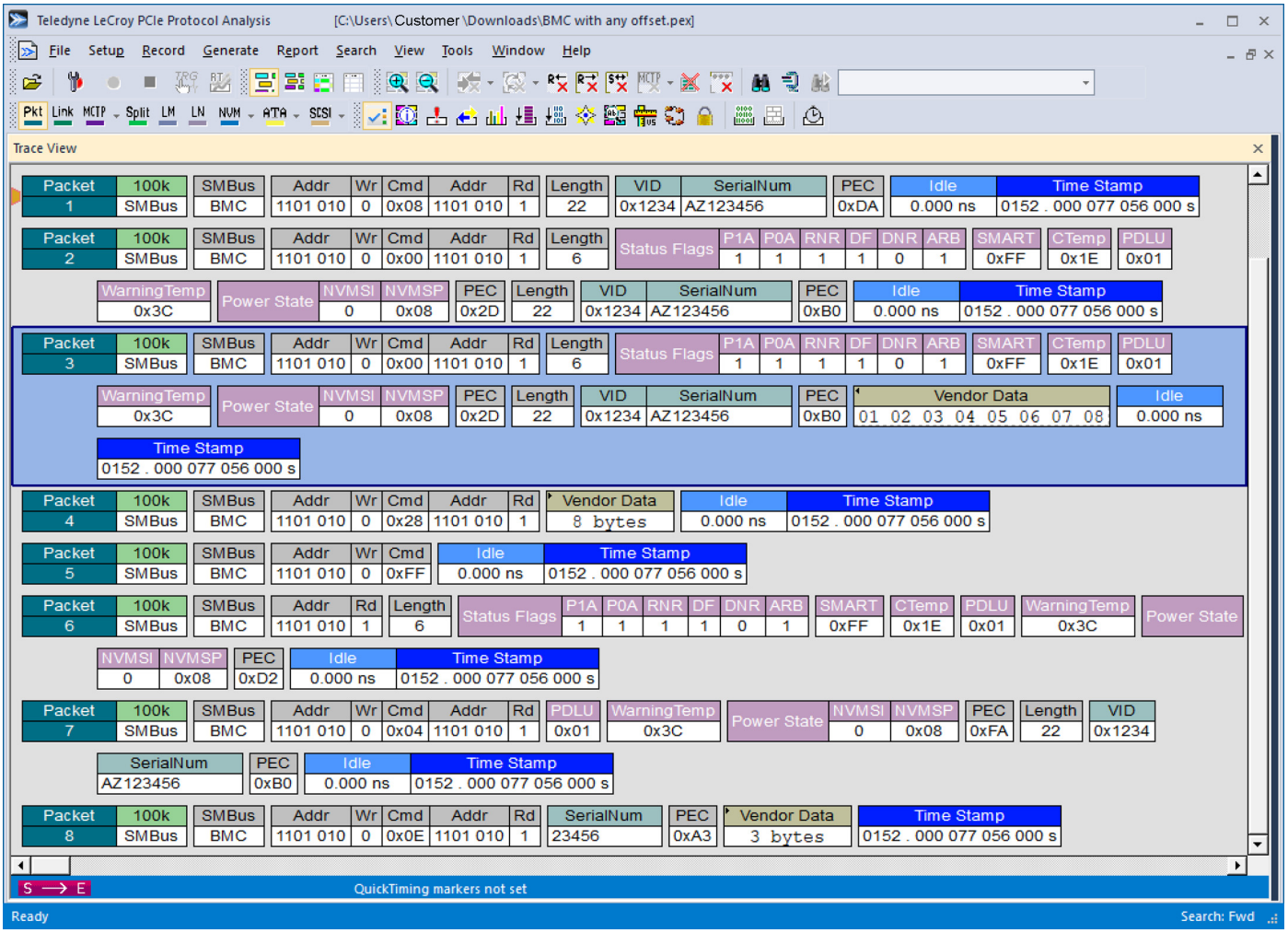


Figure 6.153: Decoding BMC Commands with Any Offset

6.11.28.4 SMBus Read Commands

When reading data from a DUT with either the ARP GetUDID command or decoding BMC transactions if there is no data in the transaction "???" will be shown in the trace. See Figure 6.154.

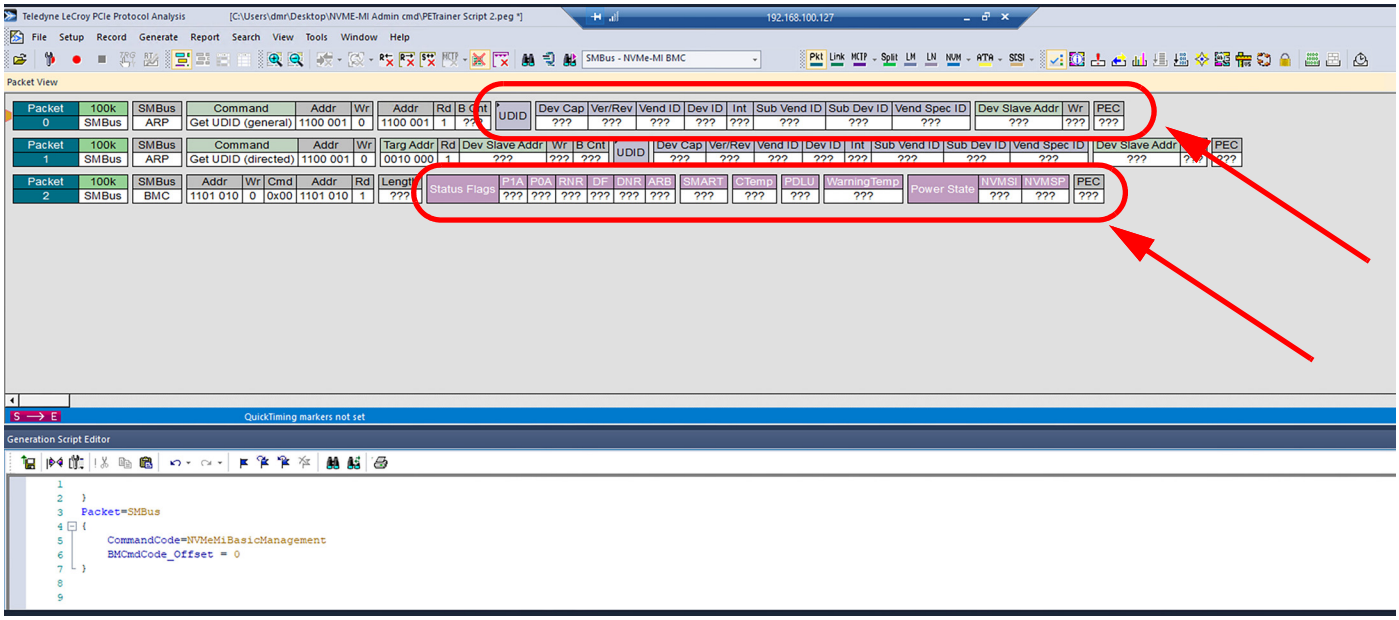


Figure 6.154: Reading BMC transactions from DUT

6.11.29 Swapping Direction of Recorded Traffic Data

Swapping Upstream/Downstream direction of traffic gives you the ability (in a recorded trace) to reverse the direction of the traffic which was recorded. See Figure 6.155.

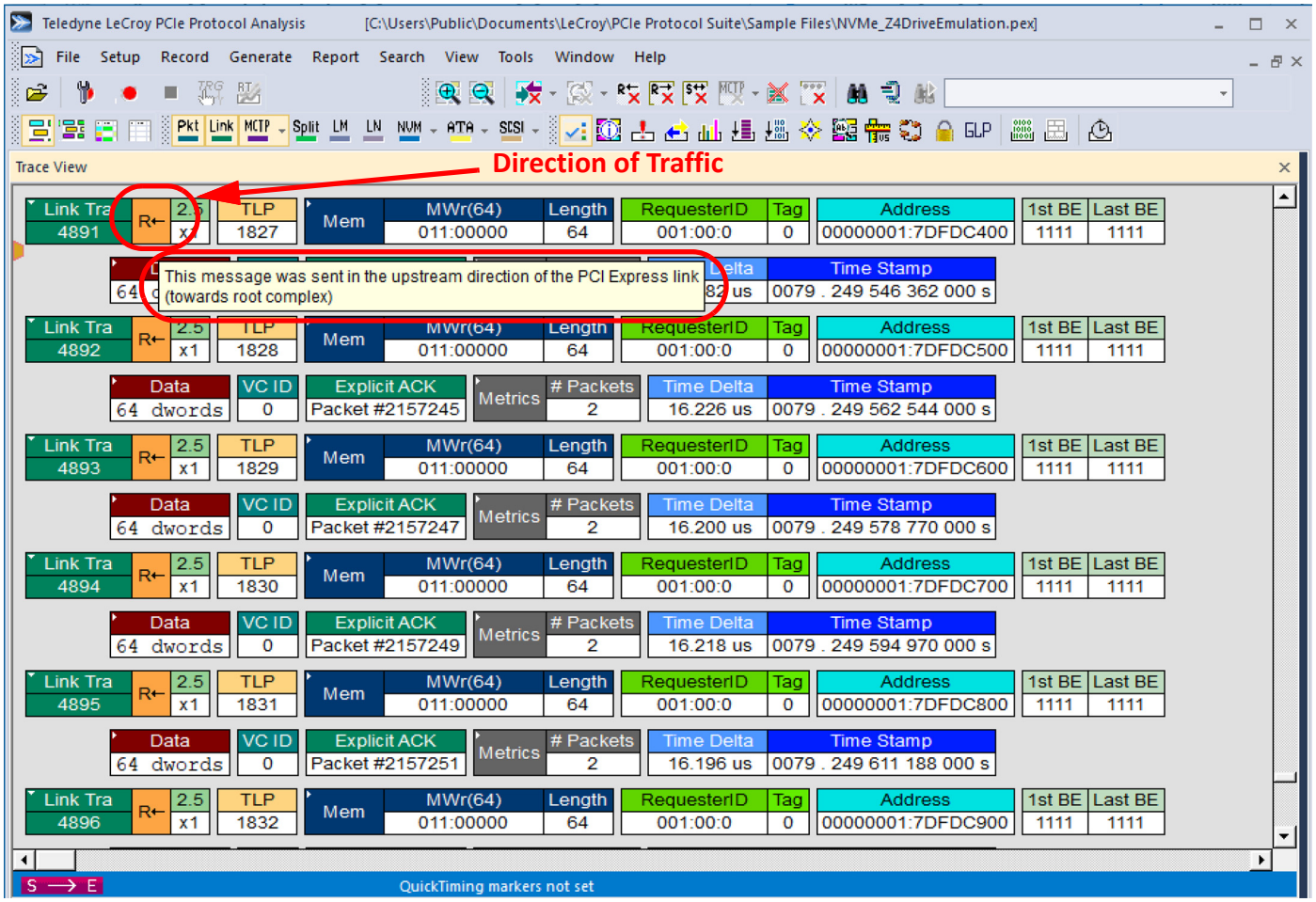


Figure 6.155: Recorded Trace: Traffic Flows in Direction it was Recorded

If you hover over the direction box (just to the right of the Link Transaction number) and perform a right click a context menu will pop up. See Figure 6.156 on page 515.

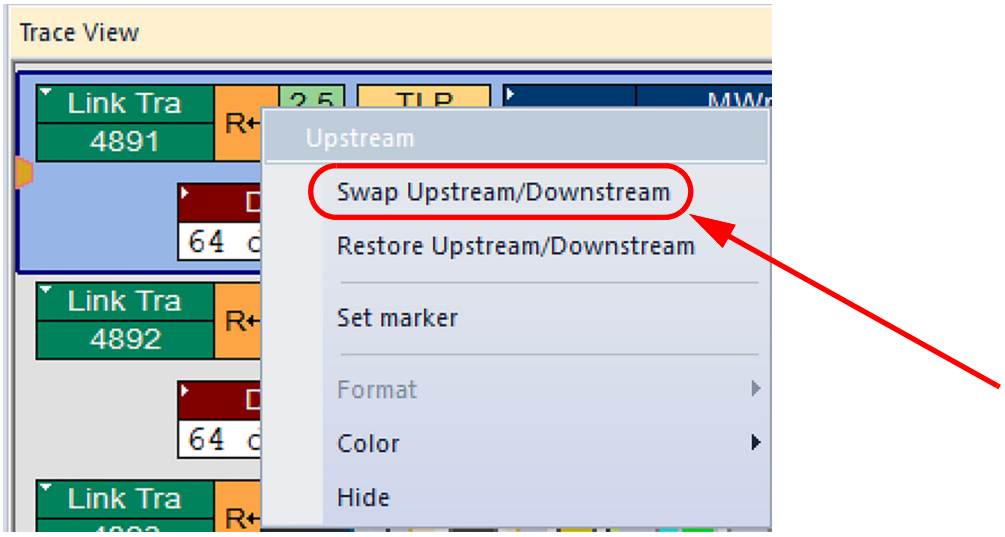


Figure 6.156: Context Menu Showing Traffic Direction

If you select Swap Upstream/Downstream the direction of the traffic will change and the tooltip will reflect that change. The color of the direction block will also change. See Figure 6.157 on page 516.

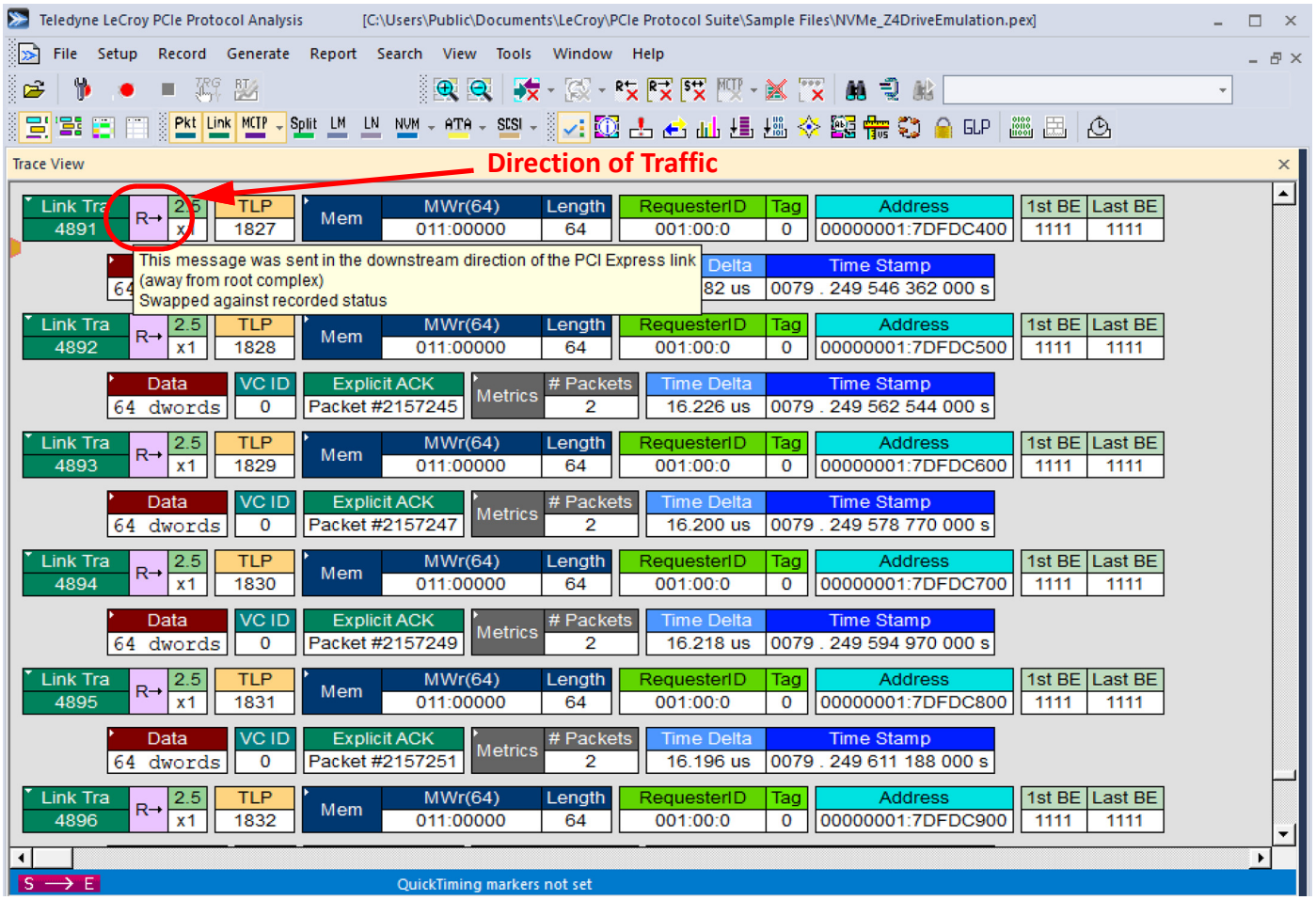


Figure 6.157: Direction of Traffic has been Swapped

If you want to swap the traffic direction back to the way it was originally recorded simply bring up the context menu (left click in the direction block) and select “Restore Upstream/Downstream”. See Figure 6.158 on page 516.

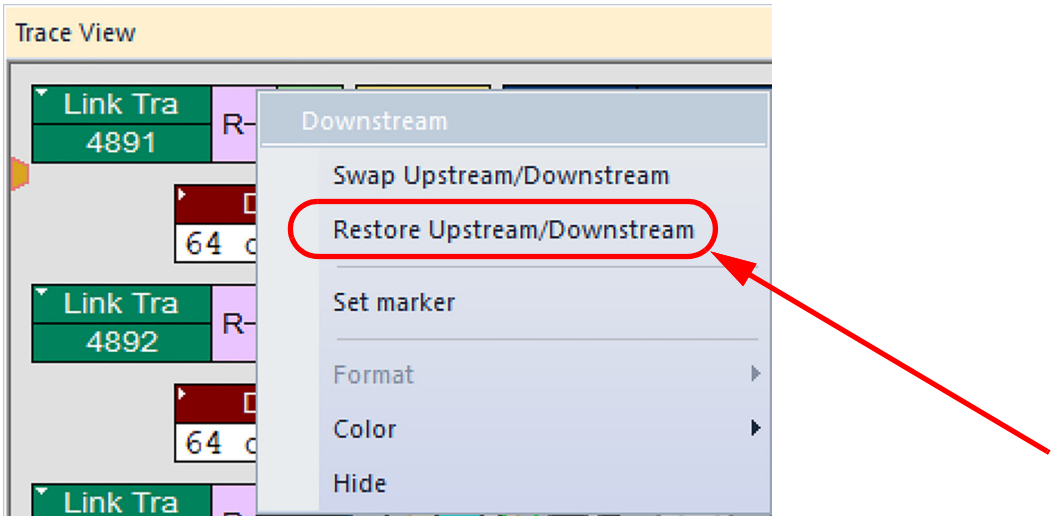


Figure 6.158: Context Menu Showing Traffic Direction: Downstream with Restore Option

6.11.30 Decoding Traces Exported from USB4 Traces with Tunneled PCIe Traffic

The PCIe Protocol Analysis Suite software is capable of decoding traces exported from USB4 traces which have tunneled PCIe Traffic.

A sample USB4 trace with PCIe tunneled traffic is shown in Figure 6.159. The highlighted Packets #6 and #7 contain Tunneled PCIe traffic with a timestamps of 7.848357050 and 7.848357082 containing DLLP types UpdateFC_Cpl and UpdateFC_NP.

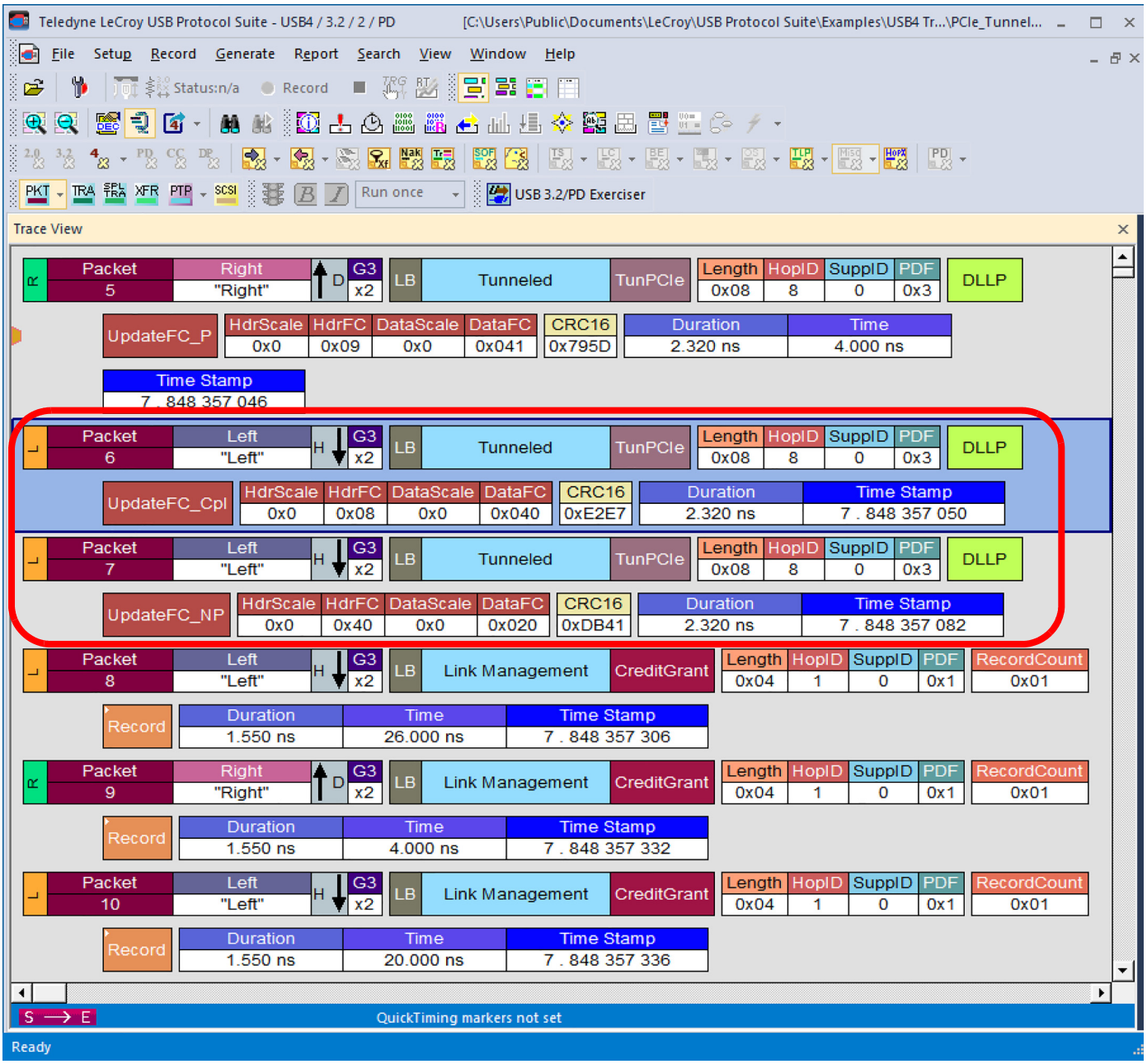


Figure 6.159: USB4 Trace with PCIe Tunneled Traffic

The PCIe Tunneled Traffic from the USB4 trace can be exported to a PCIe trace and decoded and analyzed with the PCIe Protocol Analysis software. See Figure 6.160 on page 518.

The highlighted Packets #4 and #5 contain Tunneled PCIe traffic with a timestamps of 7.848357050 and 7.848357082 containing DLLP types UpdateFC_Cpl and UpdateFC_NP.

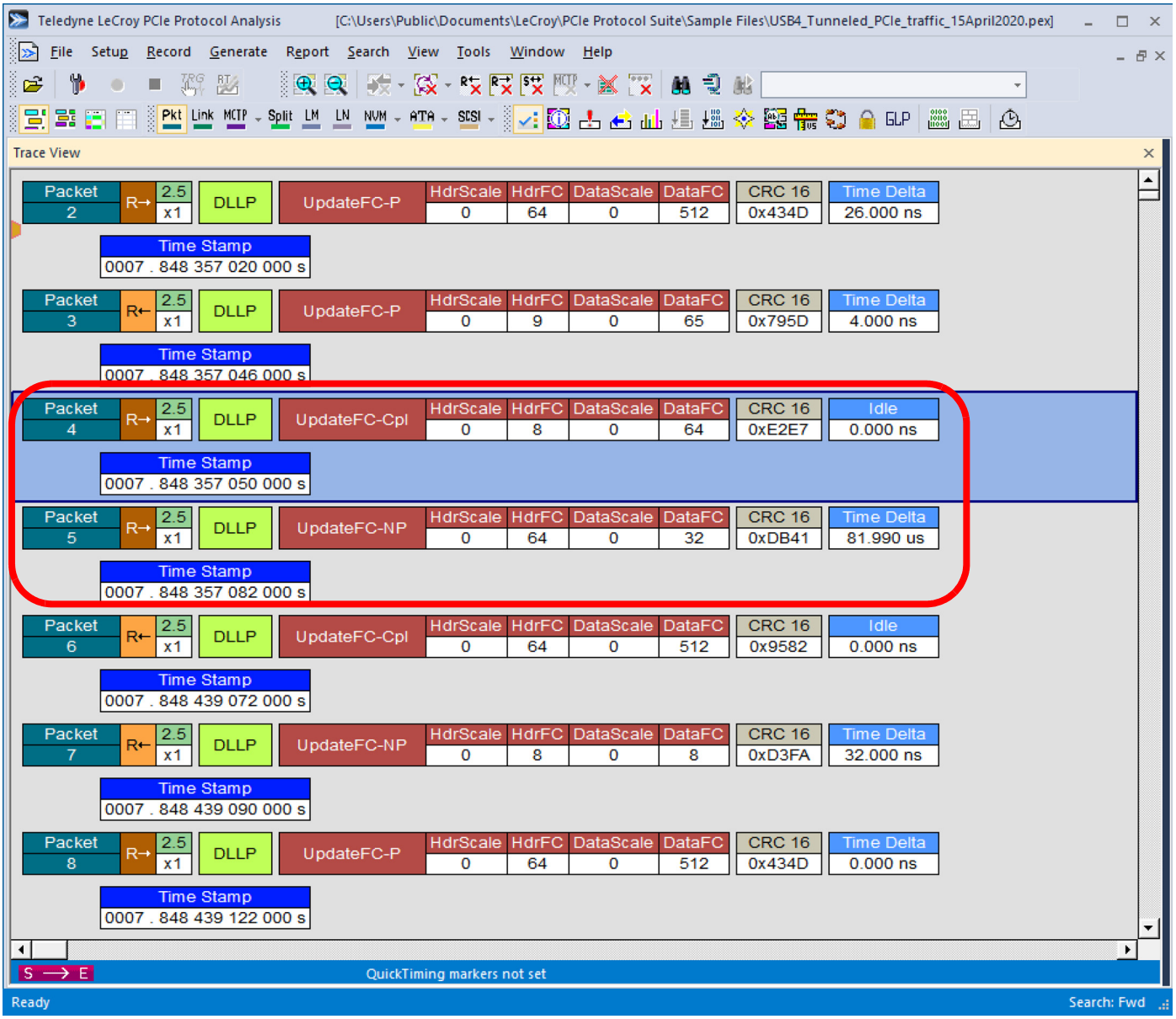


Figure 6.160: PCIe Tunneled Traffic from USB4 Trace Decoded and Analyzed by the PCIe Protocol Analysis software

Note: Link Tracker is disabled for tunneled PCIe packets intentionally, because there is no information about the PCIe link (Link Width, etc.) in USB4 tunnel.

Chapter 7

Searching CATC Traces

This chapter describes how to search for CATC Trace events.

7.1 CATC Trace Search Overview

Several search commands let you navigate a CATC Trace view to search for key events, such as errors and triggers.

To view the search options, click **Search** in the Menu bar. See Figure 7.1 on page 520.

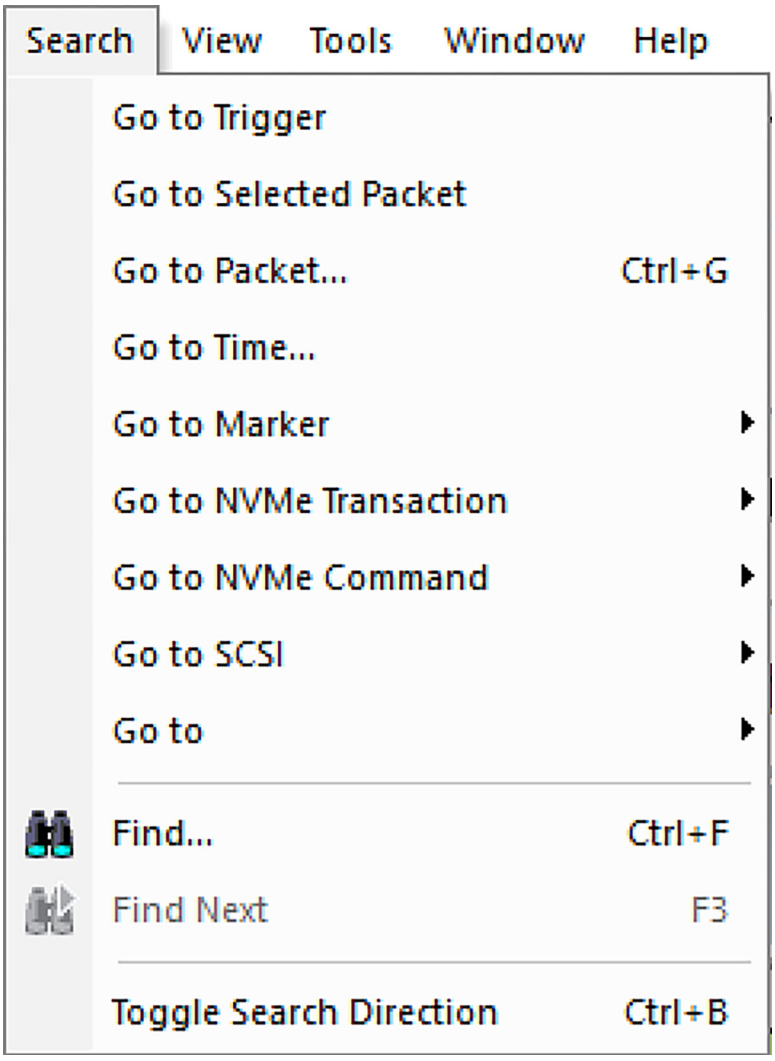


Figure 7.1: Search Menu Options

7.2 Go to Trigger

To position a trigger packet at the top of the screen:

Select **Search > Go to Trigger**.

7.3 Go to Selected Packet

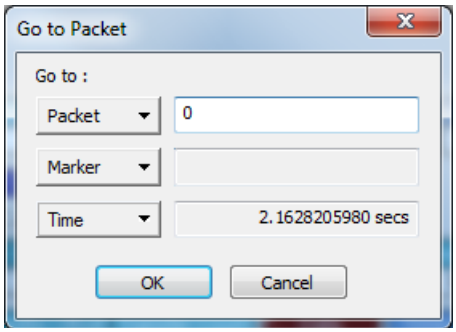
To position a selected packet at the top of the screen:

Select the packet and Select **Search > Go to Selected Packet**.

7.4 Go to Packet

To position a specific packet at the top of the screen:

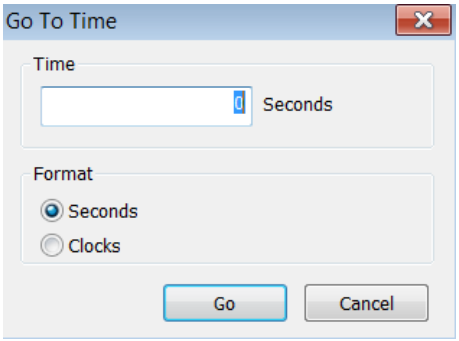
1. Select **Go to Packet** from the Search menu. A pop-up menu prompts you for the packet number, marker, or time (see the following figure).
2. Choose the needed transaction level from the Packet drop-down list and enter the transaction number. Please note that transaction levels is added to list if corresponding level is decoded for current trace file.
3. Click **OK**.



7.5 Go to Time

To position a specific time at the top of the screen:

1. Select **Go to Time** from the Search menu. A pop-up menu prompts you for the time in Seconds or Clocks.



2. Enter the time and format (seconds or clocks).
3. Click **Go**.

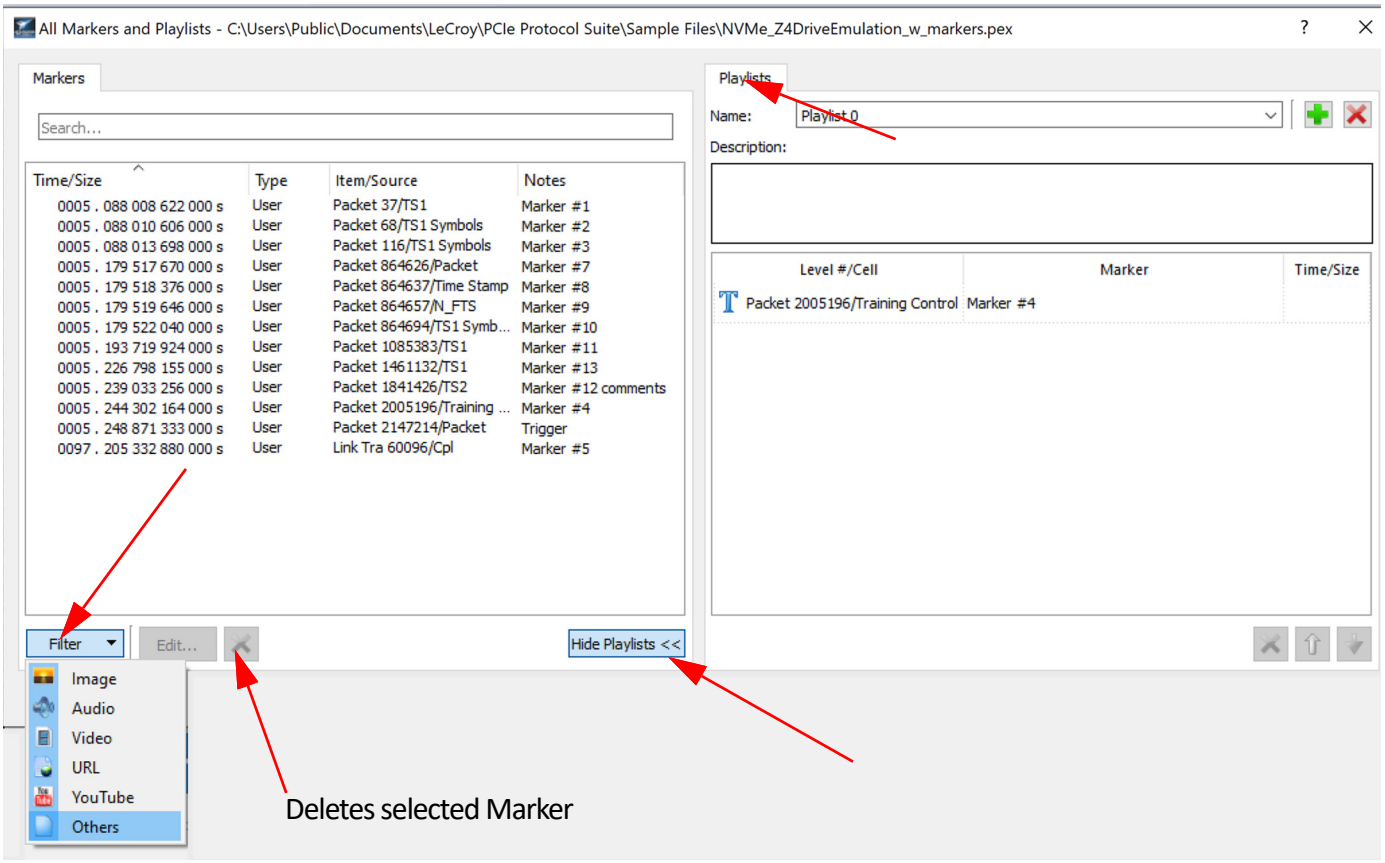
7.6 Go To Marker

Use this operation to go directly to a specific packet or transaction that has been marked with a unique marker by the Set Marker operation.

To go to a marker:

1. Select **Go To Marker** from the Search Menu.

2. Select the marker you want from the fly-out menu.
   Alternatively, select **All Markers** to display the All Markers and Playlists dialog, then select a marker and click **OK** (see figure on next page).



7.6.1 Markers

This section explains the features of Markers. A marker is an entity that flags a physical or logical item of interest within a trace file. A marker contains one or more attachments. You can add a marker to a trace file or unmark a trace file by removing the marker.

Markers are represented graphically in a different way in the application.You can not only add markers to the packets but it is granular enabling you to also add markers to individual cells.

7.6.1.1 Markers Overview

This functionality provides the user an easy way to navigate through attachments which is a discrete piece of information or data added to a marker, for example, a text description or file, an attachment of a trace file by a predefined order, video or audio files, URL links or any other files.

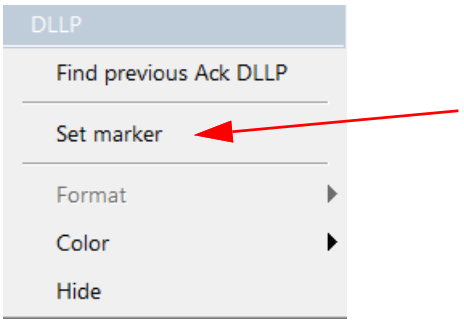
7.6.1.2 Functionality of Markers

The markers functionality allows you to add markers to:

- Whole packets or frames
- Specific Cells
- Specific values within a cell: Bytes, words, etc.
- The Timestamp of a Packet

You can add attachments to markers.

Right-click on any cell of a packet and select **Set Marker** from the menu as shown below.



The Create Marker dialog displays (see Figure 7.2 on page 524).

7.6.1.3 Set New Marker

Markers are useful to identify specific points in the data. By default markers follow a numbering convention but can be renamed. Markers can also be inserted by using the keyboard (see Figure 7.2 on page 524):

- Hover your mouse pointer over a packet and press **Ctrl+K** to insert a marker for that packet.
- Click a packet to select it and press **Ctrl+L** to insert a marker for that packet.

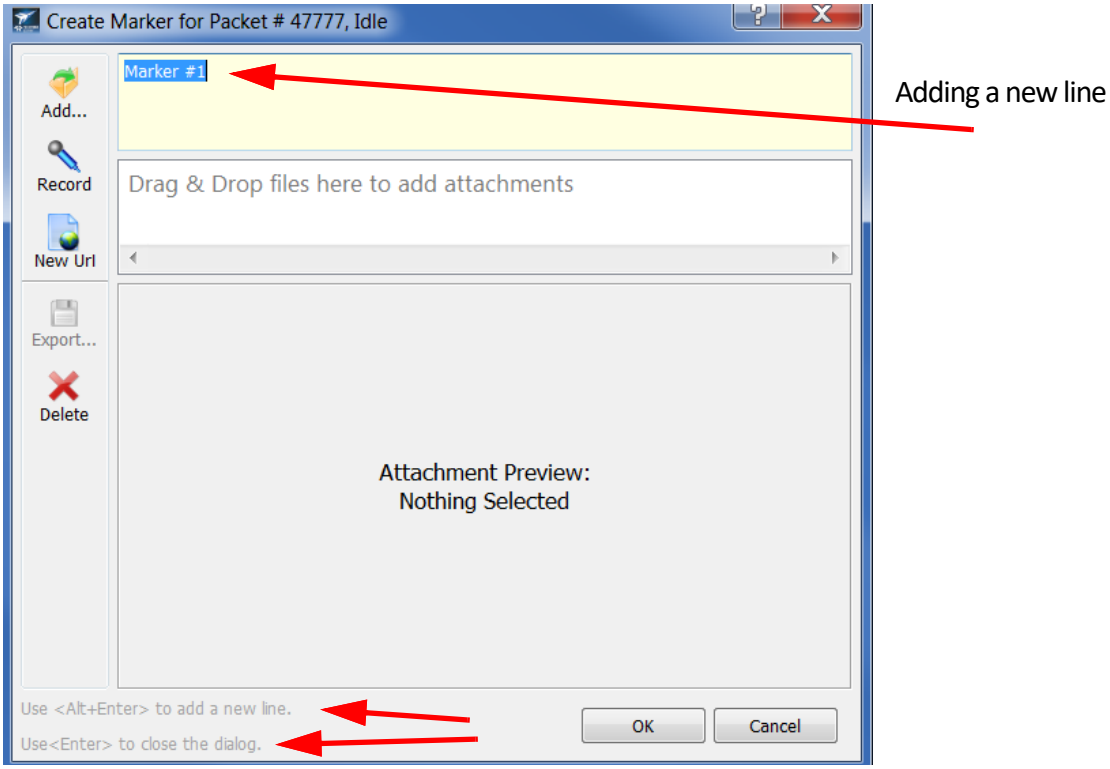


Figure 7.2: Create Marker for Packet Dialog

Click **Enter** to close the Marker dialog.

Click **ALT > Enter** to add a new line.

As shown above you can:

Add...	Add icon. Click on this icon to add any file. See "Adding an Attachment" on page 524.	Export...	Export icon. Click on this icon to export an attachment.
Record	Record icon. Click on this icon to record audio. See "Recording an Audio File" on page 525.	Delete	Delete icon. Click on this icon to delete an attachment
New Url	New URL icon. Click on this icon to add any URL.		

7.6.2 Attaching Markers

You can attach a discrete piece of information/data to a marker, for example, a text description or file, an attachment of a trace file by a predefined order, video or audio files, URL links or any other files. You can also remove an attachment from a Marker.

7.6.3 Adding an Attachment

Perform the following steps to add an attachment to a marker:

1. Right-click on any cell in the trace and select **Set Marker.**
   The Create Marker window displays (see Figure 7.3 on page 525).
2. Click on the **Add** icon.
   The **Add File to the Marker** dialog displays.
3. Go to the file and select it to add it to the marker as an attachment.
4. Click **Open**.
   The file will appear in the Create Marker for Packet... dialog. The Marker # appears in the top panel, the icons are displayed in the second panel and you can click on the icon on the third panel to view the file you are about to attach.
5. Click **OK** to add the attachments.

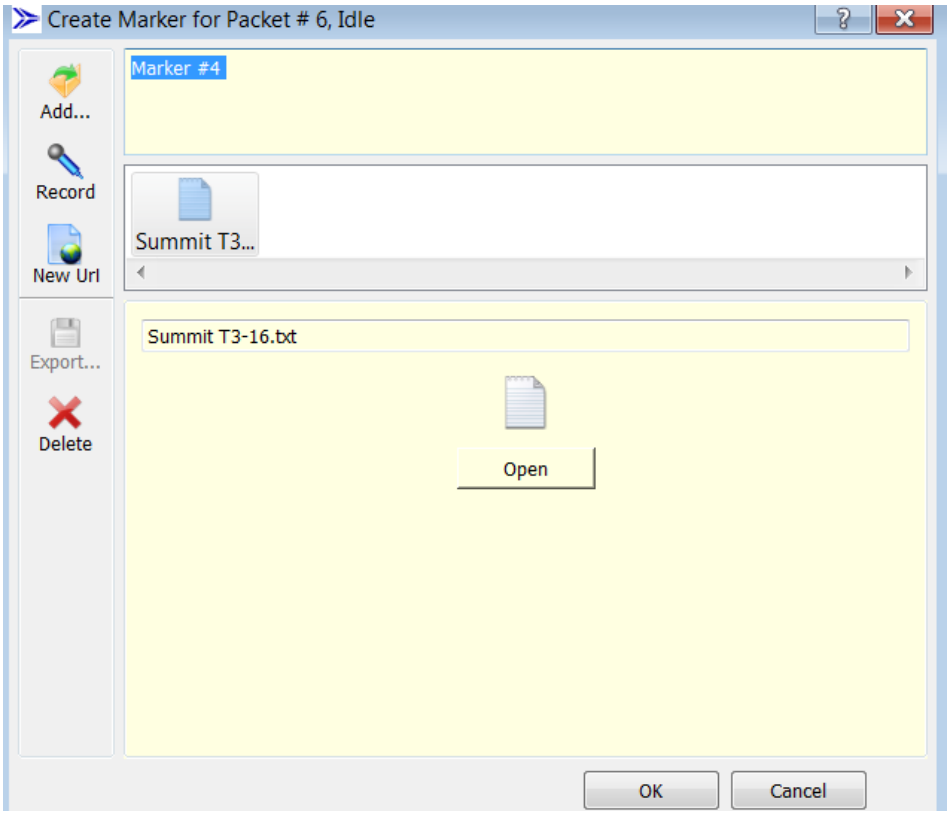


Figure 7.3: Create Marker for Packet Dialog

7.6.4 Recording an Audio File

The audio quality supports voice attachment and is not designed for high-quality audio Playback of audio content is not limited and depends on the formats supported by the installed playback engine.

Click the record icon and speak into the microphone to record an audio file.

Note: This functionality is disabled if a microphone is not installed.

7.6.5 Video Files Supported

The user can attach video clips to the trace file ("add to the marker"). The playback of the Video clips is limited to the formats that are supported by the video codecs installed in the system.

7.6.6 Attachment Types and Visualization

The markers are represented graphically by a yellow triangle at the top right of the marked item and a red vertical bar at the left-most cell of a packet as shown below.

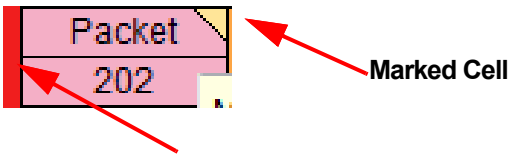


Figure 7.4: Marked Cell

A marker may comprise any number of attachments of any types.

7.6.7 Embedded Attachments to a Marker

Embedded files are attached to the item marked and transported with the trace. You can embed the following types of files to a marker:

- Audio Files
- Video Files
- Image Files
- YouTube Files
- Web Pages
- Text Attachments
- Other Attachments

Attachments are embedded in the marker and saved in the trace file. Once attachments are placed in a marker, the marker can then be presented to a user in a story structured form. On opening the marker the window resembles the marker editing dialog.

Note: The use of Audio and Video markers is limited to the file types supported on a user's system. CATC Walk has been tested with .mp3 and .wmv files, which are supported by Windows as installed. If additional codecs are installed, they should also work, but it is the user's responsibility to choose formats that will work for whomever they intend to exchange CATC trace files (no different than email attachments in this regard). Because of this dependency on installed codecs, there are situations where bugs in the codecs supplied by Microsoft or third-party applications can prevent proper operation of the Teledyne LeCroy PCIe Protocol Analysis application. See the Teledyne LeCroy PCIe Protocol Analysis Application Read-Me file for more information if you have problems with application crashes, etc.

7.6.8 Viewing Attachments of a Marker

If you hover over the marked cell (yellow triangle at the top right of the marked item), refer to "Attachment Types and Visualization" on page 526, a window pops up displaying the contents of the marked cell (see Figure 7.5 on page 527).

While hovering over the marked cell, it can start playing the start of the audio or video file, but it will stop after a short time due to the Analyzer's host system timeout for Tooltips. You must click on it to open the audio or video attachment for further listening or viewing.

To view an attachment you can click on any of the icons in the attachment bar and or you can double-click on the icon itself to open the attachment.

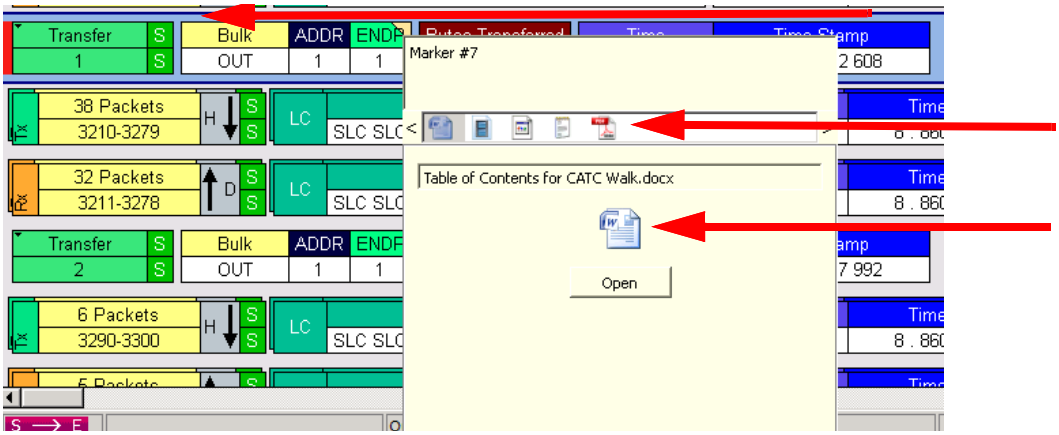


Figure 7.5: Pop-up Displaying Marker Contents

7.6.8.1 Text

The text attachment is displayed in the icon bar and in the main pop-up window. Text attachments are always shown at the top. The attachment file name is displayed in the field as shown below.

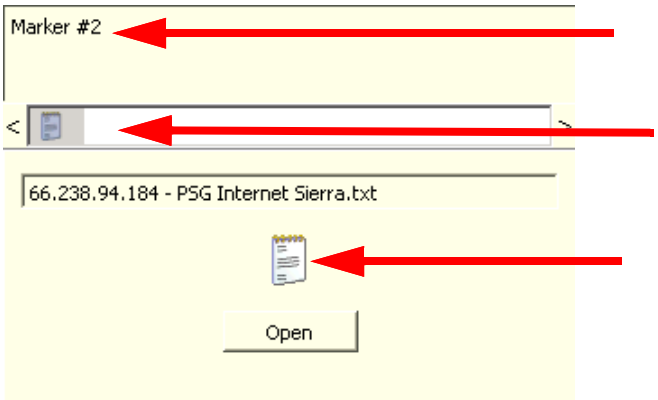


Figure 7.6: Text Attachment Pop-up Window

If there is no attachment, **No Attachments** displays in the status bar at the bottom.

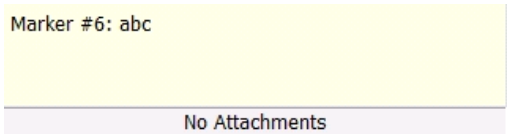


Figure 7.7: No Attachments Pop-up Window

If there are attachments, the status bar is hidden. You can move the cursor to an attachment icon in the list view and a preview of the attachment starts (see Figure 7.8 on page 528).

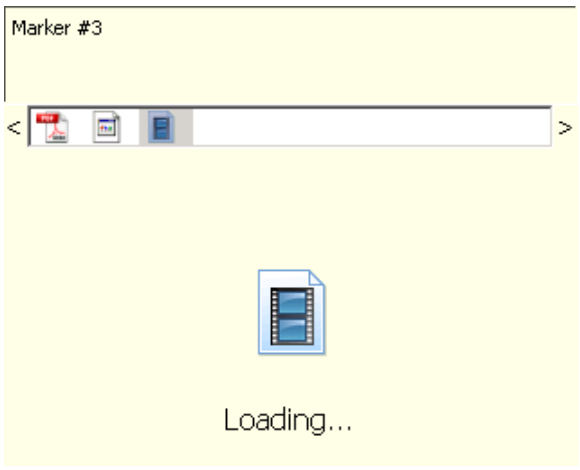


Figure 7.8: Preview Attachments Pop-up Window

7.6.8.2 Audio

Audio snippets that are recorded and attached to certain point of interest in a trace can be played. The basic Play, Start, Stop, Pause buttons are displayed to listen to the audio file.

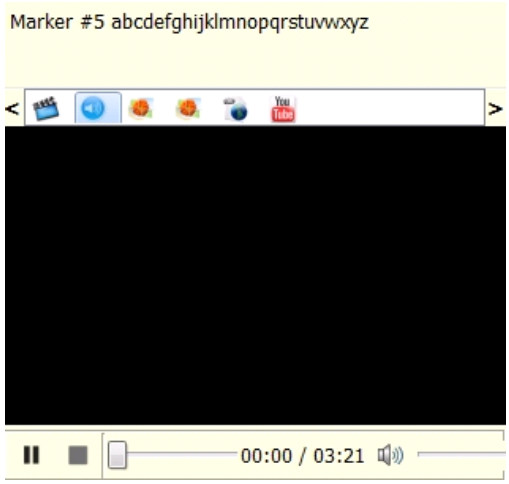


Figure 7.9: Audio Clip Attachment

7.6.8.3 Video

Video clips that are recorded and attached to certain point of interest in a trace can be played. The video is embedded in the tooltip with simple playback controls.



Figure 7.10: Video Clip Attachment

7.6.8.4 File Attachment

You can attach any kind of file, including images, PDFs, documents, media files, etc.

7.6.8.5 URL Link

You can specify a URL that links to a web page (i.e., YouTube), a network location, or a local file-system location. See Figure 7.11.

Web Link

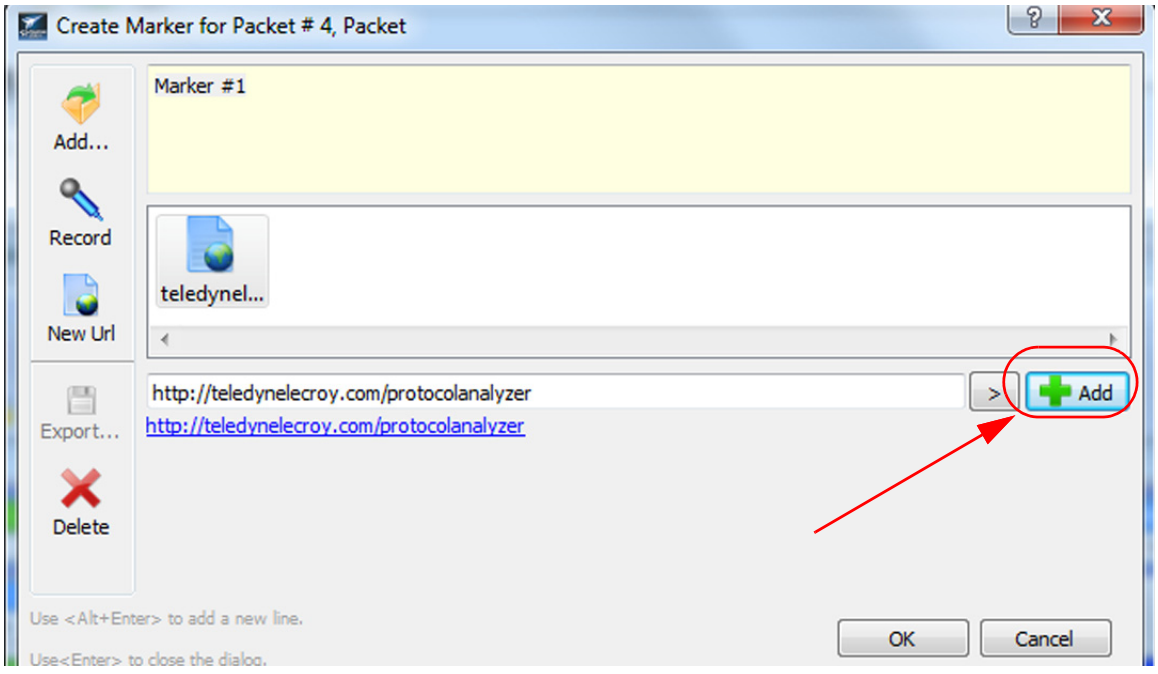


Figure 7.11: Marker: URL Link

After you add the URL marker to the Packet, when you click on the URL it will open in a separate browser window. See Figure 7.12.

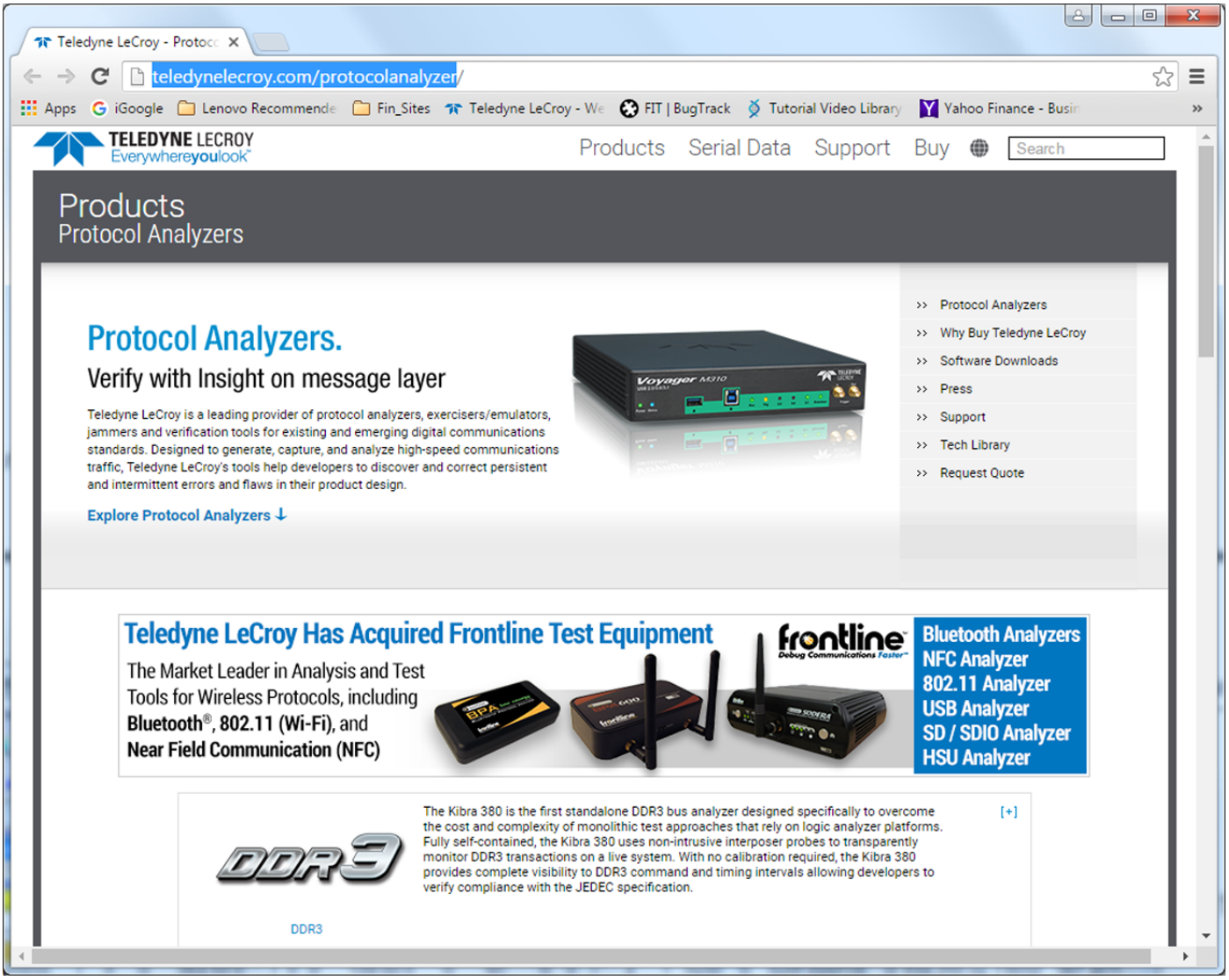


Figure 7.12: Opening a URL Marker in a Separate Window

7.6.8.6 YouTube Video

YouTube's video player is embedded for YouTube Video playback.



Figure 7.13: YouTube Video Attachment

7.6.8.7 Images

The image is embedded in the trace.



Figure 7.14: Image Attachment

7.6.8.8 Other Attachments

Click the **Open** button to open the attachment file with the system's default application for that file type.

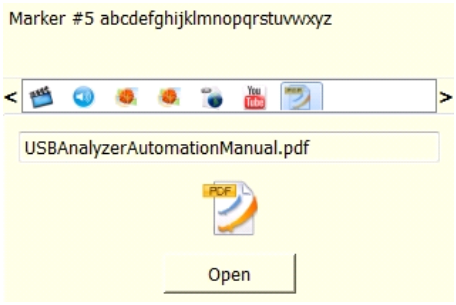


Figure 7.15: Other Attachment

7.6.9 Edit Marker

To edit a marker, right-click on the marked item and select **Edit marker** from the menu or **Ctrl + L**. The Edit Marker dialog displays. This Edit Marker window can be used to edit one marker at a time.

You can do the following in the Edit Marker dialog:

- Edit text attachment.
- Record audio attachment.
- Add URL link attachment
- Add a file attachment. Click on **File** and click the **Open** button or drag and drop the file.
- Preview audio/video/image/URL/YouTube attachment or open other files with system default application.
- Save an attachment to a file.
- Remove attachment.

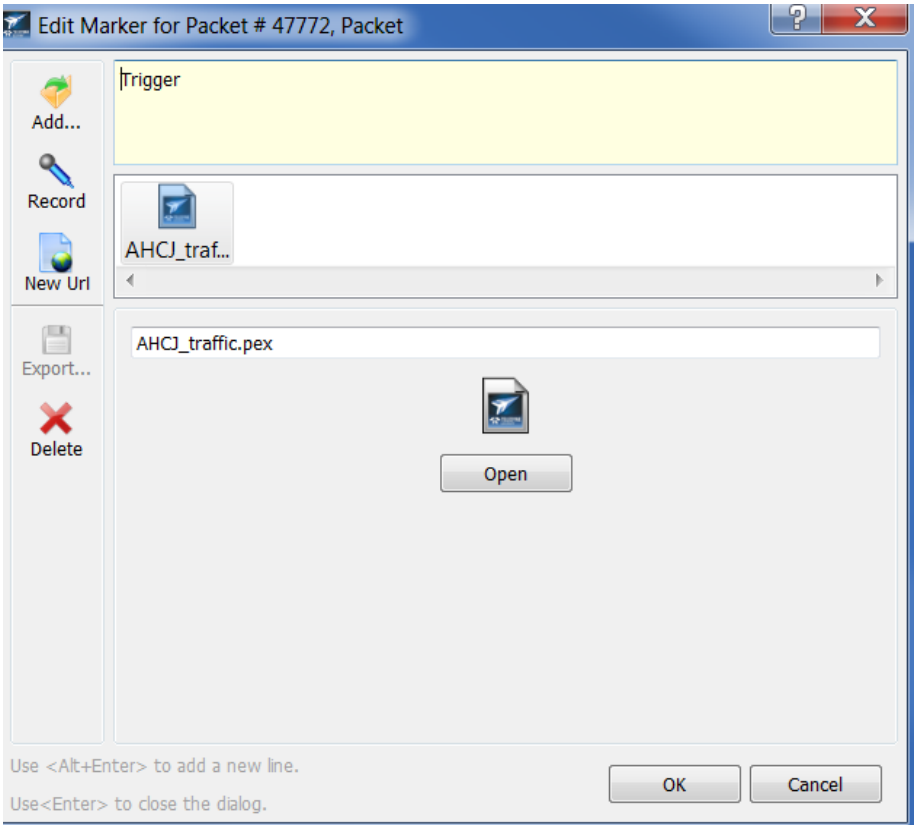


Figure 7.16: EDIT Marker for Packet Dialog

7.6.10 All Markers Dialog

Select **Search > Go to Marker > All Markers** or press **Ctrl + M** to display a list of all the markers in the file. The dialog uses a tree structure to show packets, fields and markers (see Figure 7.17 on page 534). The features of the Markers dialog are:

- All Markers are displayed.
- All attachments within the marker are displayed. Hovering over the marker displays a tool-tip displaying the size of all the attachments.
- You can collapse or expand the item marked to view the attachments.
- The Time and size of audio and video files are displayed.
- You can edit Playlists from this window.
- You can edit, delete a marker or delete all markers from this location.
- You can filter attachments within the marker.
- You can select a range of markers by clicking **Shift** and selecting a range.
- You can select multiple markers by clicking **Ctrl** and selecting individual markers.
- Double-click on a marker to go to that marker in the trace and close the dialog.
- You can sort by Timestamps (or any other displayed title) in ascending or descending order. See Figure 7.18 on page 535.

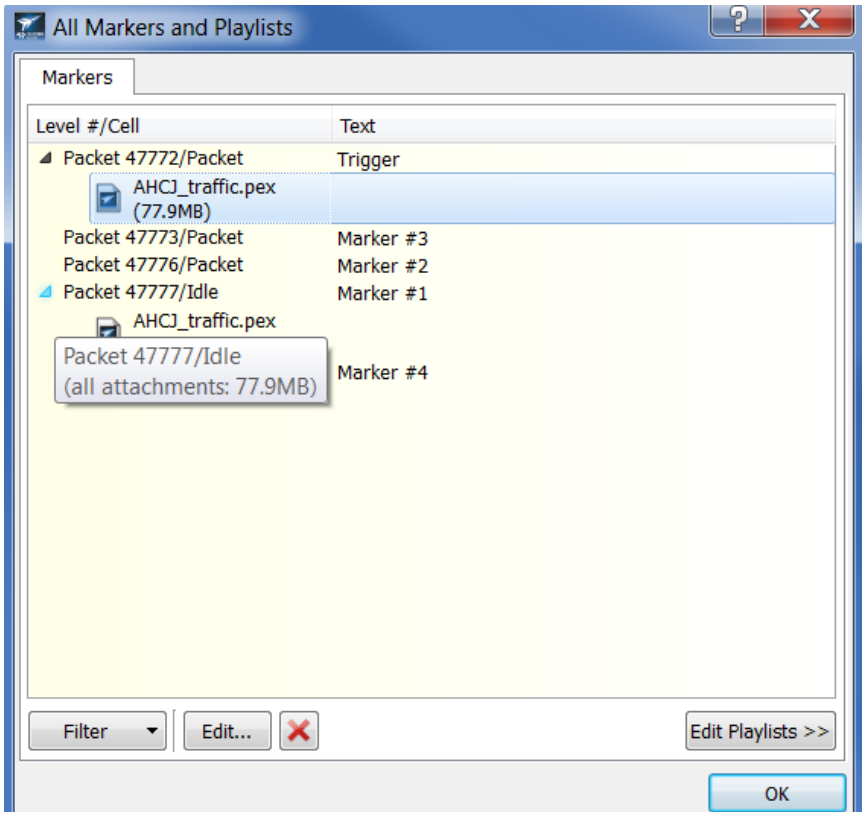


Figure 7.17: All Markers and Playlists Dialog

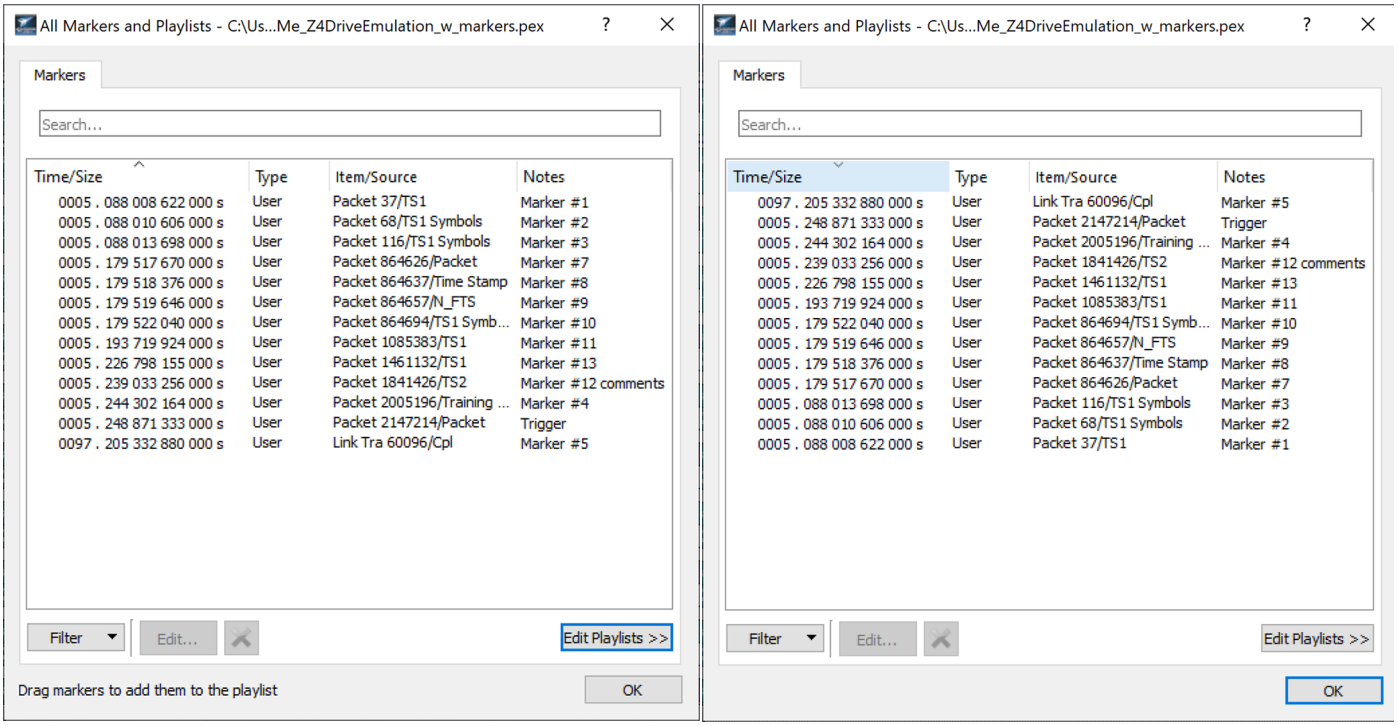


Figure 7.18: Markers Sorted by Timestamps in Ascending and Descending Order

You can filter to show or hide text, image, audio, video, URL, YouTube videos and other files.

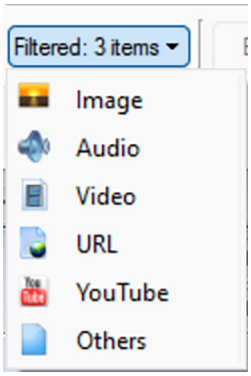


Figure 7.19: Filter Dialog

Clicking delete on markers to delete markers with attachments displays the Delete Marker(s) dialog. Checking the “Don’t ask again” checkbox will not display this confirmation dialog again.

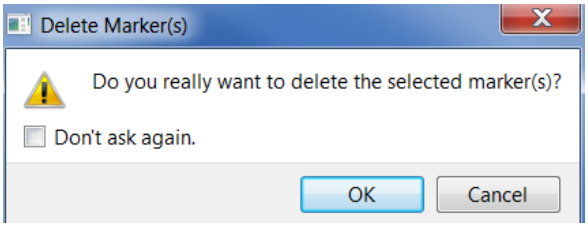


Figure 7.20: Confirmation Dialog

7.6.11 CATC Walk Playlist

This feature allows users to configure sequences of attachments into playlists. Any arbitrary order of attachments are allowed, and there are no limits on the number of playlists supported. This feature can be used for collaborating among developers as well for training, support and marketing purposes.

To access a playlist click on the **View** menu in the top toolbar of application, select **CATC Walk** and then select **Manage Playlists** as shown below.

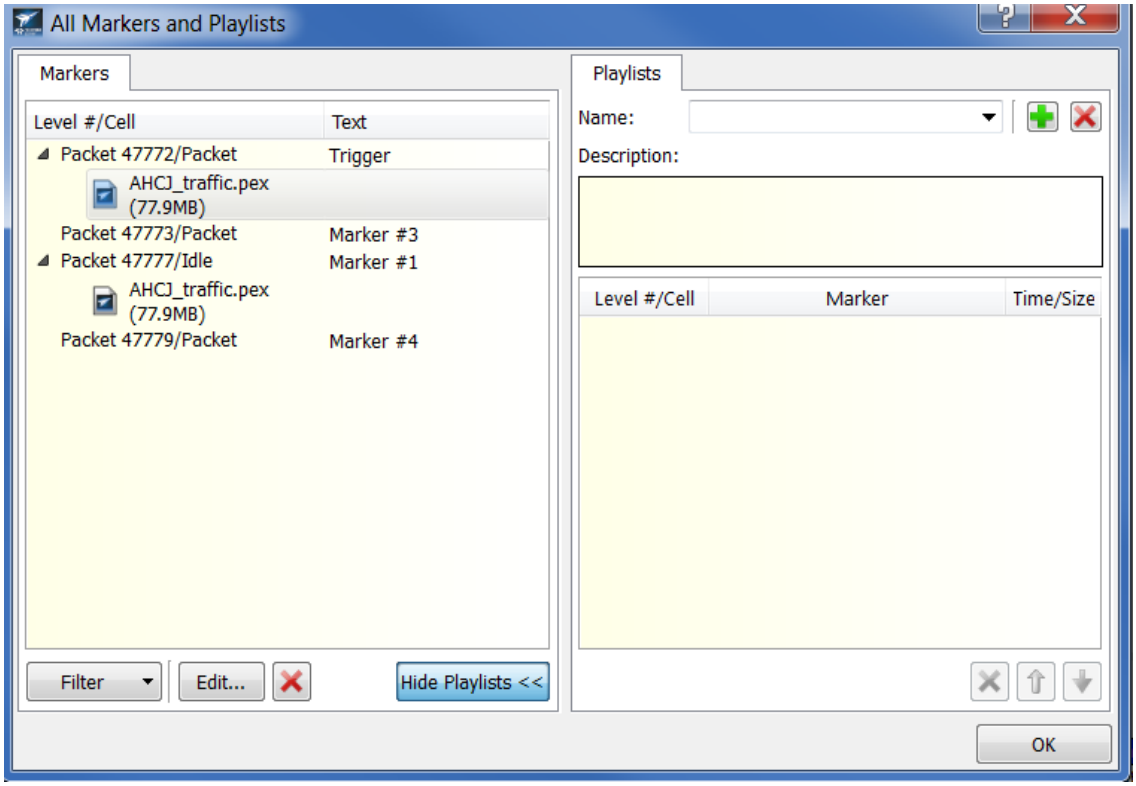


Figure 7.21: Edit CATC Walk Playlists Dialog

7.6.12 Playlist Functionality

You can do the following to manage playlists:

- Remove or edit current playlists
- Edit the playlist name
- Edit the playlist description
- List the sequence of attachments in current playlist
- List of all available attachments and drag/drop to a playlist.

As shown in the previous figure the Playlist window lists the markers with their attachments on the left and the playlist on the right.

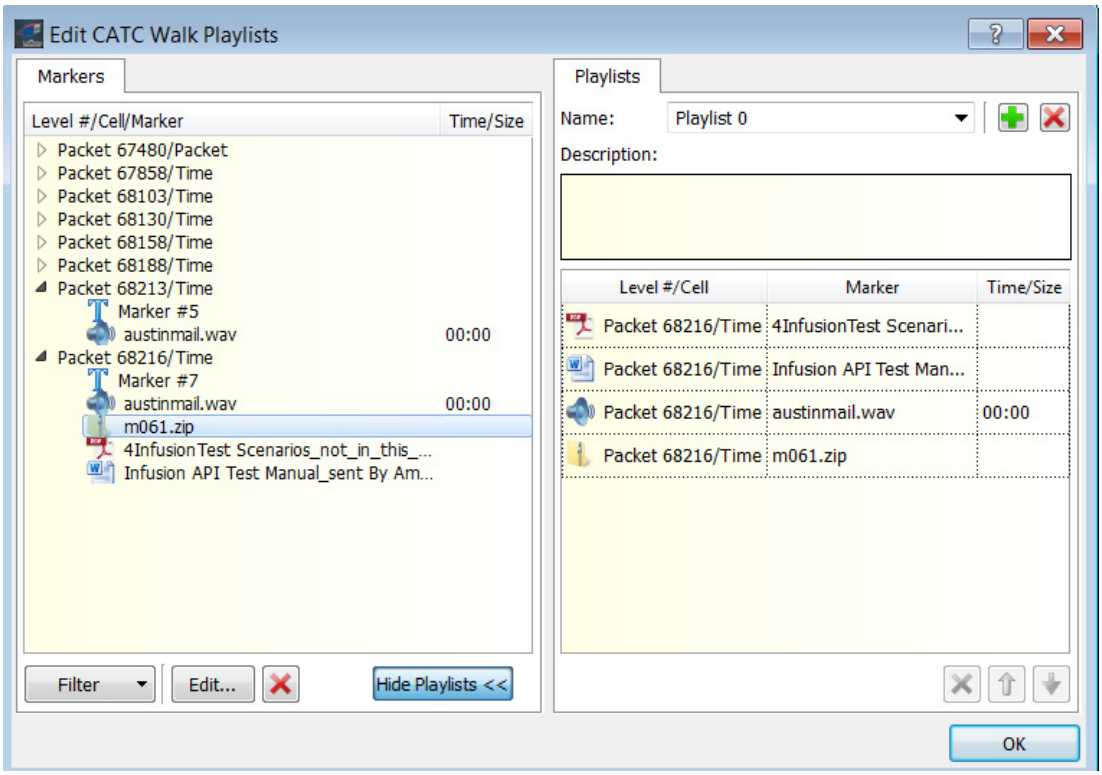


Figure 7.22: Edit CATC Walk Playlists Dialog

You can drag and drop and item or attachment from the **Marker** panel into the **Playlist** panel and build a story. Give a description of the playlist in the **Description** field and you can give a name to the playlist in the **Name** field.

You can add a new playlist by clicking on the green plus sign (+) on the right top corner of the Playlist panel, or delete a playlist by clicking the red (x) button.

If you have more than one playlist saved click on the Name drop-down arrow to select it. The drop-down menu lists all the available playlists

7.6.13 Playback Window

To playback a playlist, click on the **View** menu in the top toolbar of application, select **CATC Walk** and then select **Play > Playlist 1** as shown below.

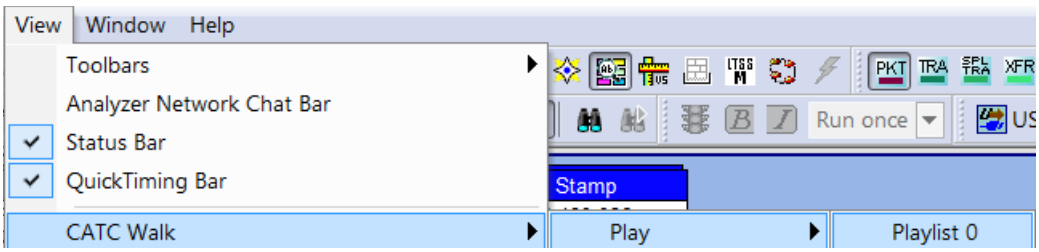


Figure 7.23: View Dialog

The attachment item starts to play in the Playback window (see Figure 7.24).

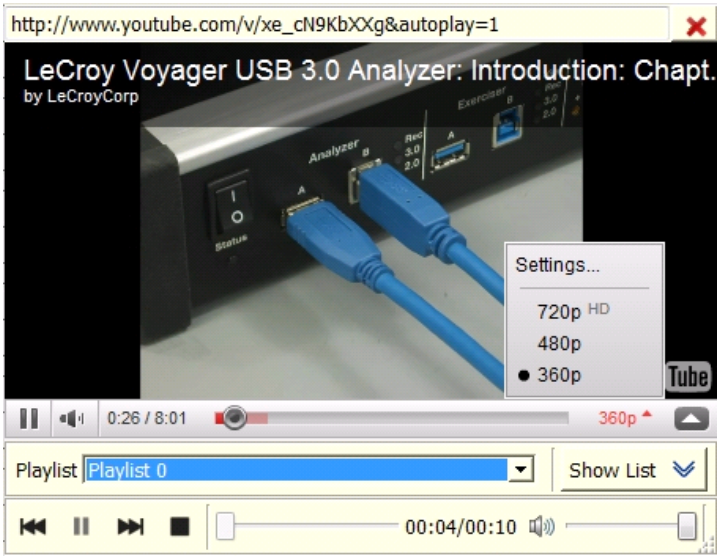


Figure 7.24: Playback Window

The playback window is re-sizable. The close button at the top right corner and the size grip for resizing at the bottom right corner will hide automatically when moving the cursor out of the window.

Users can provide commentary to a captured trace, converting it into a script or a story and can transfer this meta-information to others.

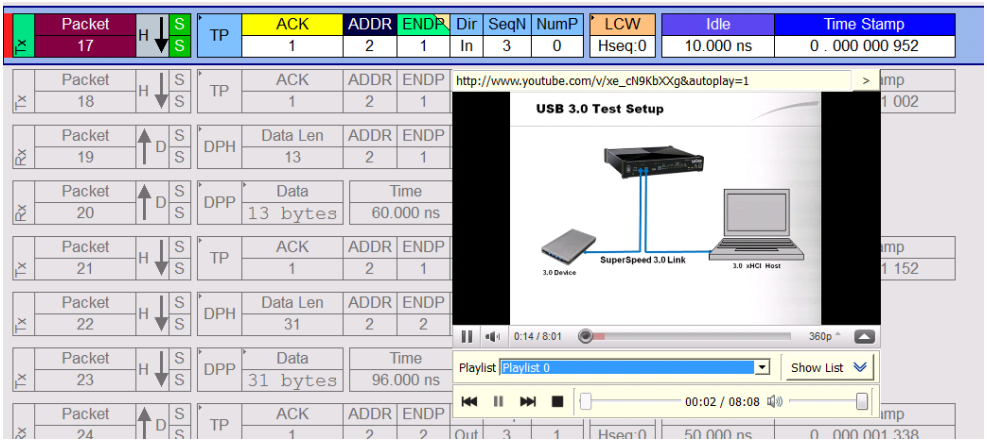
7.6.13.1 Playlist Playback Controls

The playlist playback control buttons are (see the screen capture on the next page):

- Play/Pause
- Stop
- Jump to Next attachment
- Jump to Previous attachment
- Seek slider for seeking to positions in media streams
- Volume slider
- Playback speed slider (for text attachments)

As a playlist is played back, the playback window is displayed in close proximity to the marked area, just like a regular tooltip window.

As the playback progresses, the view jumps to the element corresponding to the current attachment being played and the marked element is highlighted. During playback the user is prevented from interacting with the trace. To reinforce this restriction, the trace view is grayed-out visually, and only the packet with the item corresponding to the current attachment is colorized.



Playlist Playback View

7.7 Go to NVMe Transactions and Commands

The Go to NVMe Transaction and NVMe Command tabs in the Search menu provides a quick way to search for both NVMe Transactions and NVMe Commands.

7.7.1 NVMe Transaction

The NVMe search capability can also search for the following types of NVMe Transactions:

- Controller Registers
- Other NVMe Entities
- Doorbell Registers
- Admin Submission Command Set
- NVM Submission Command Set
- Completion Queue Entry
- NVMe Errors

As shown in Figure 7.25 on page 540

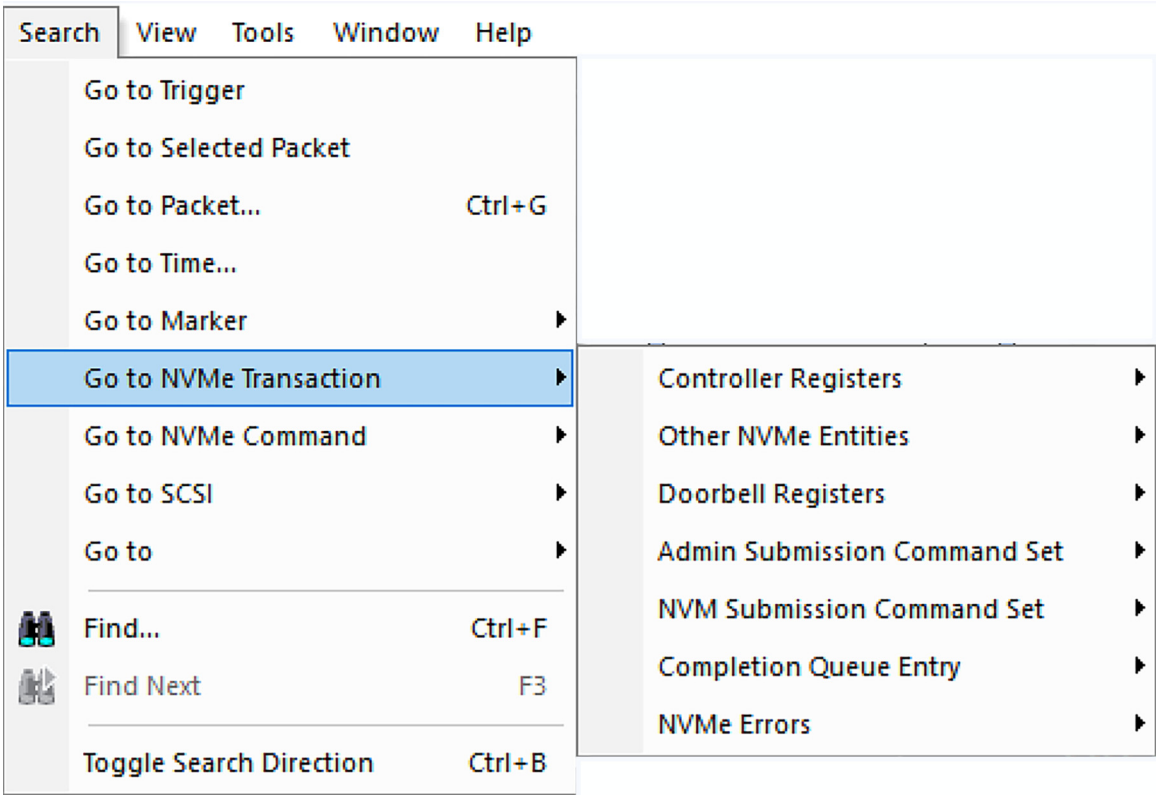


Figure 7.25: Search: NVMe Transaction Types

7.7.2 NVMe Command

The NVMe search capability can also search for the following types of NVMe Commands:

- Admin Command Set
- NVM Command Set
- Status
- Errors
- TCG Types
- TCG Method
- TCG Invoker
- TCG Com ID
- TCG Ext Com ID

As shown below in Figure 7.26 on page 541.

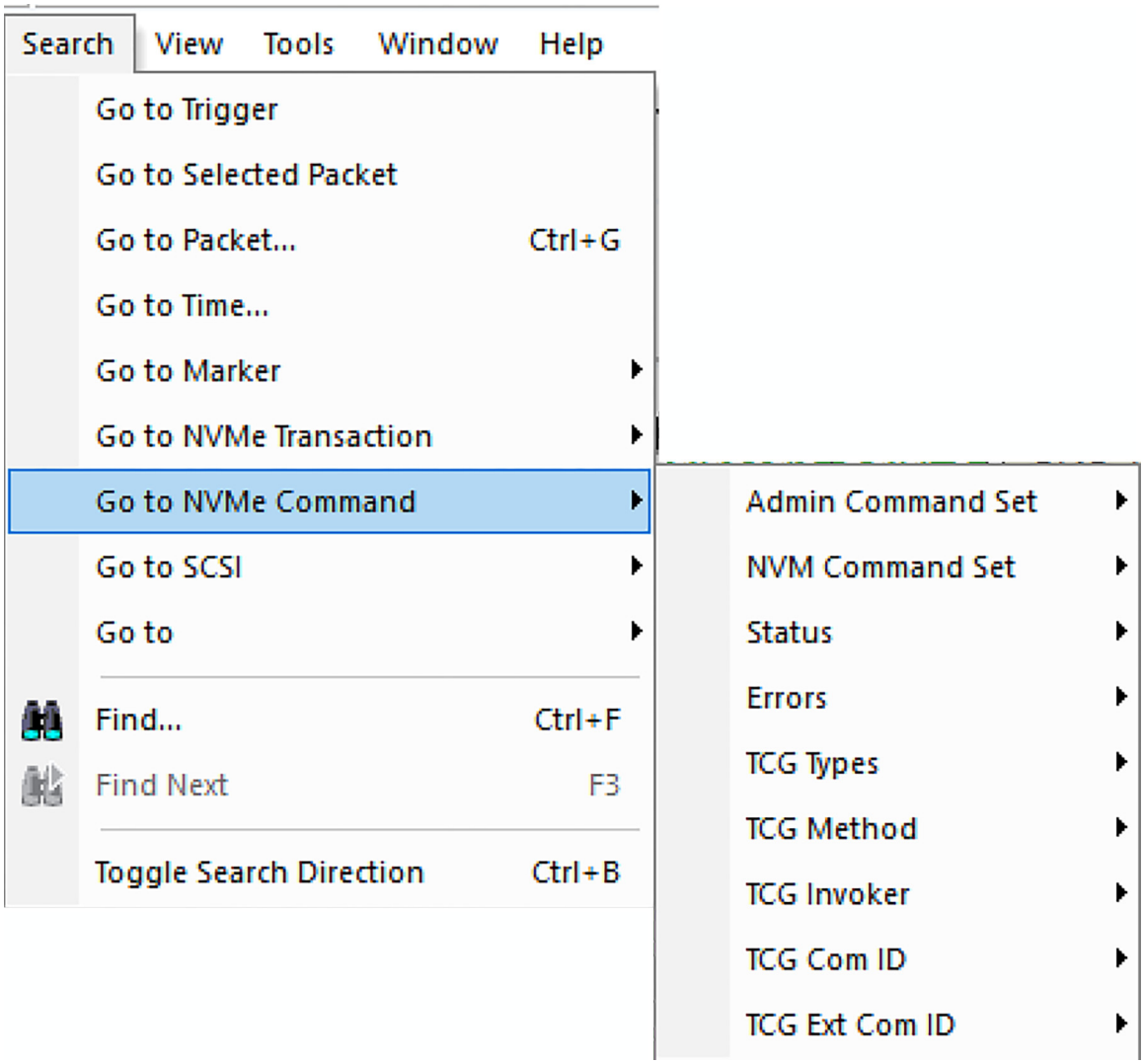


Figure 7.26: Search: NVMe Command Types

7.8 Go To SCSI Menu

The **Go To SCSI** menu in the Search menu provides a quick way to search for a packet based on a SCSI commands and sub-commands. You can search for the following types of events:

- SCSI Operation
- Command Status
- Task Management
- Task Management Response
- Error
- SCSI Logical Unit Number

7.9 Go To Menu

The **Go To menu** in the Search menu provides a quick way to search for a packet based on a simple condition. You can search for the following types of events:

- TLP Type
- DLLP Type
- Ordered Set
- Link Event
- OBFF Message
- Traffic Class
- DLLP Virtual Channel
- TLP Virtual Channel
- Direction
- Speed
- Link Width
- Requester ID
- Completer ID
- Data Lengths
- Errors

7.9.1 Example: Search -> Go to -> Link Event -> Link Up/Link Down

Use the Search -> Go to function to find Link Event: Link Up or Link Down.

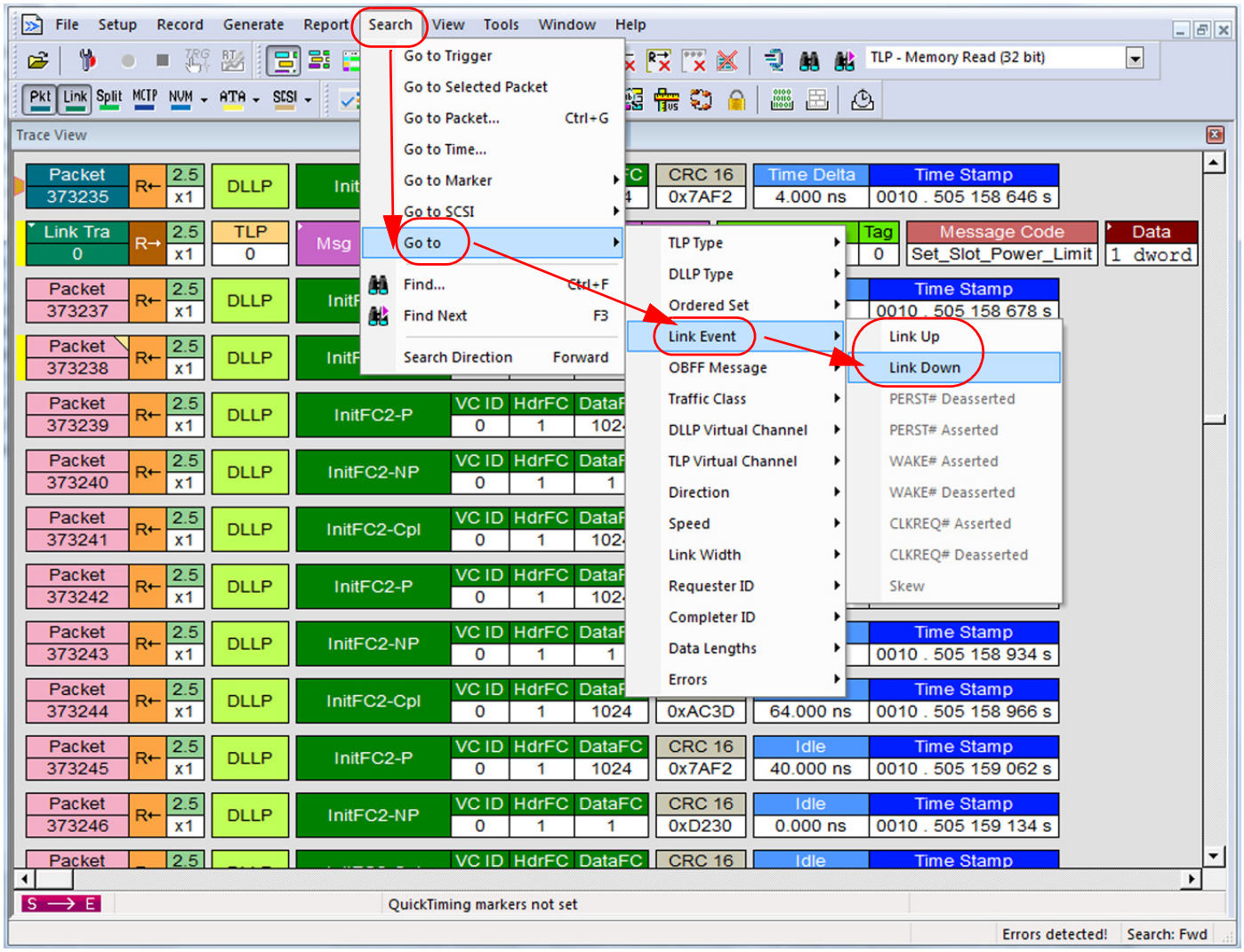


Figure 7.27: Search -> Go to -> Link Event -> Link Up / Link Down: Set Up Search

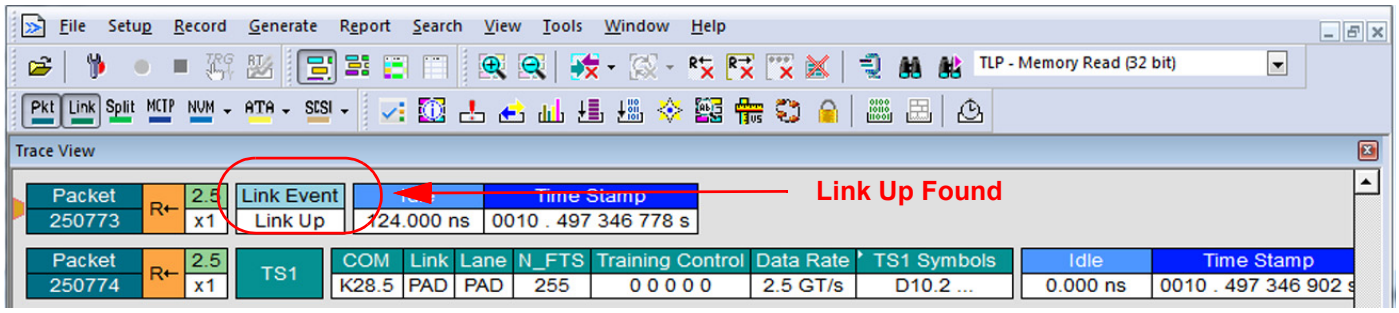


Figure 7.28: Search -> Go to -> Link Event -> Link Up: Found

7.9.2 Example: Search -> Go To -> Direction

The Search -> Go To -> Direction option will show you Upstream, Downstream and Sideband.

See Figure 7.29.

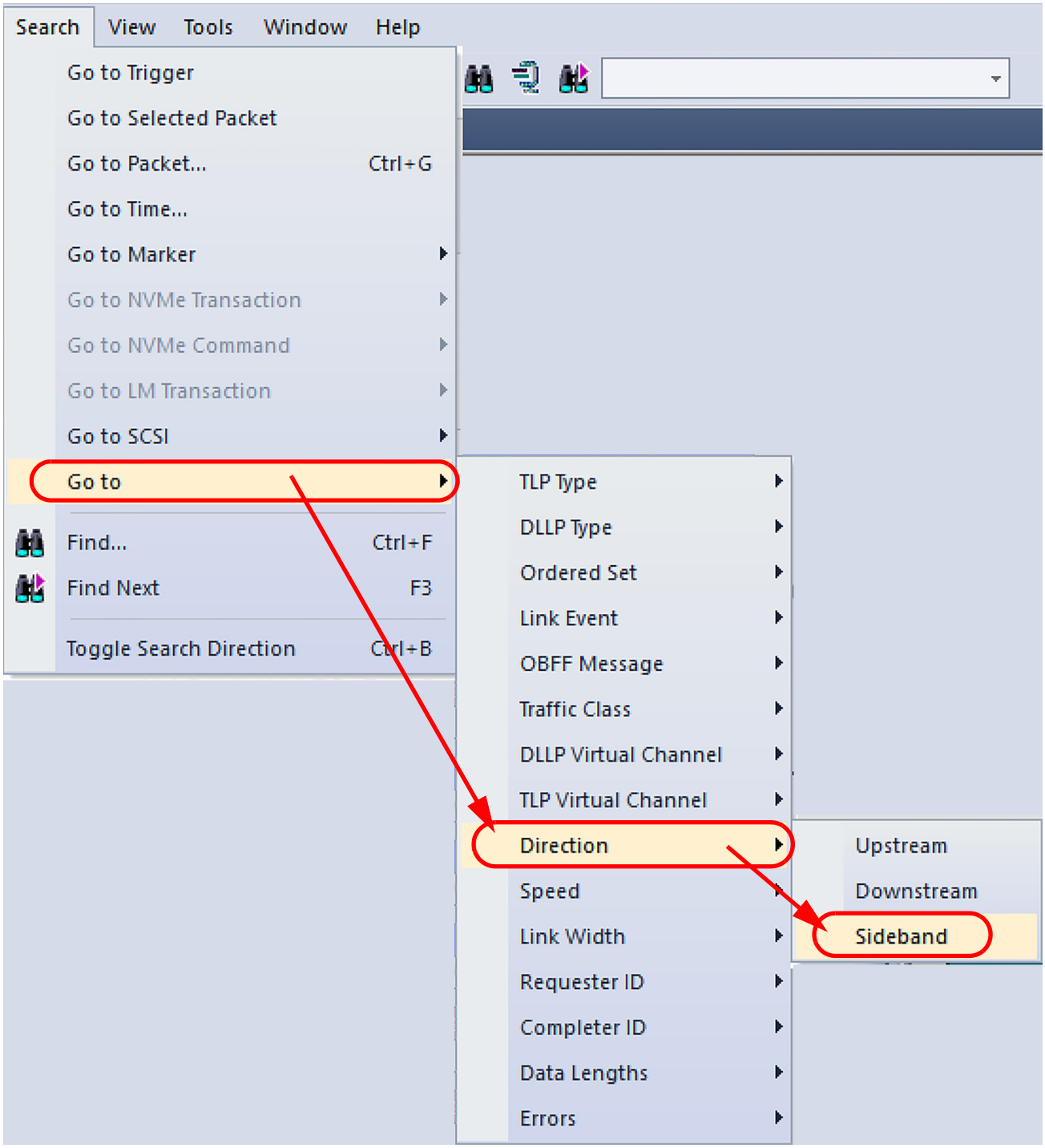


Figure 7.29: Search -> Go To -> Direction -> Sideband

7.10 Find

Find allows you to conduct complex searches in a CATC Trace. You can search by protocol level (Packets, Link Transactions, Split Transactions, NVMe, PQI, AHCI, ATA).

You can search packets by Event Group: TLP Type, TLP Header, TLP Prefix, TLP Requester ID, TLP Completer ID, TLP Data Pattern, TLP Data Lengths, TLP Tag, TLP Sequence Number, DLLP Type, DLLP Header, DLLP Virtual Channel, ACK/NAK Seq Number, Ordered Sets, Link Event, OBFF Code, Direction, Errors, TS1 Data, TS2 Data.

You can search link transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag.

You can search split transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag, Address.

You can search NVMe transactions by the following Event Groups: Controller Registers, Queue IDs, Command IDs, Doorbell Registers, Admin Submission Command Set, NVMe Submission Command Set, Completion Queue Entry, and PRP.

You can search PQI transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag, Address.

You can search AHCI transactions by Event Group: AHCI Register ID, AHCI Port Number, AHCI Slot Number, AHCI Port Multiplier Port, AHCI Raw Address AHCI Direction and, AHCI Errors.

You can search ATA transactions by Event Group: ATA Register Type, ATA Port Number, ATA Slot Number, ATA Raw Address, ATA port Multiplier Port, ATA Interruption Reason, ATA Error Type ATA Input/Output, ATA Payload Portion, ATA CFIS Fields, ATA RFIS Device to Host Fields, ATA DSFIS Fields, ATA PSFIS Fields, ATA SDBFIS Fields.

You can search SOP transactions by Event Group: SOP Information Unit ID, SOP Errors.

You can search SCSI transactions by Event Group: SCSI Operation, Command Status, Task Management, Task Management Response, Errors, SCSI Logical Unit Numbers.

You can search for NVMe Commands by Event Group: Admin Command Set, NVM Command Set, Submission QID, Completion QID, Status, Errors, NVM Command, NVM Payload Portion, TCG Types, TCG Method, TCG Invoker, TCG Com ID or TCG Ext Com ID. See “Example: Search for NVMe Command” on page 562.

You can search for MCTP messages by Event Group: MCTP Message Type, MCTP Control Command Codes, MCTP Control Completion Codes and MCTP Control Instance ID. See “Example: MCTP Messages to Search For” on page 566. You can also search for PLDM and NC-SI message types within MCTP messages. See “Example: Searching for PLDM Message Types within MCTP Messages” on page 567 and “Example: Searching for NC-SI Message Types within MCTP Messages” on page 568.

The options Union, Intersection, and Exclusion allow you to create complex searches such as “Find x OR y” or “Exclude all x or y.”

To find an item:

1. Open a CATC Trace.
2. Open Find by selecting **Search > Find** from the menu or clicking  (see the following screen capture).

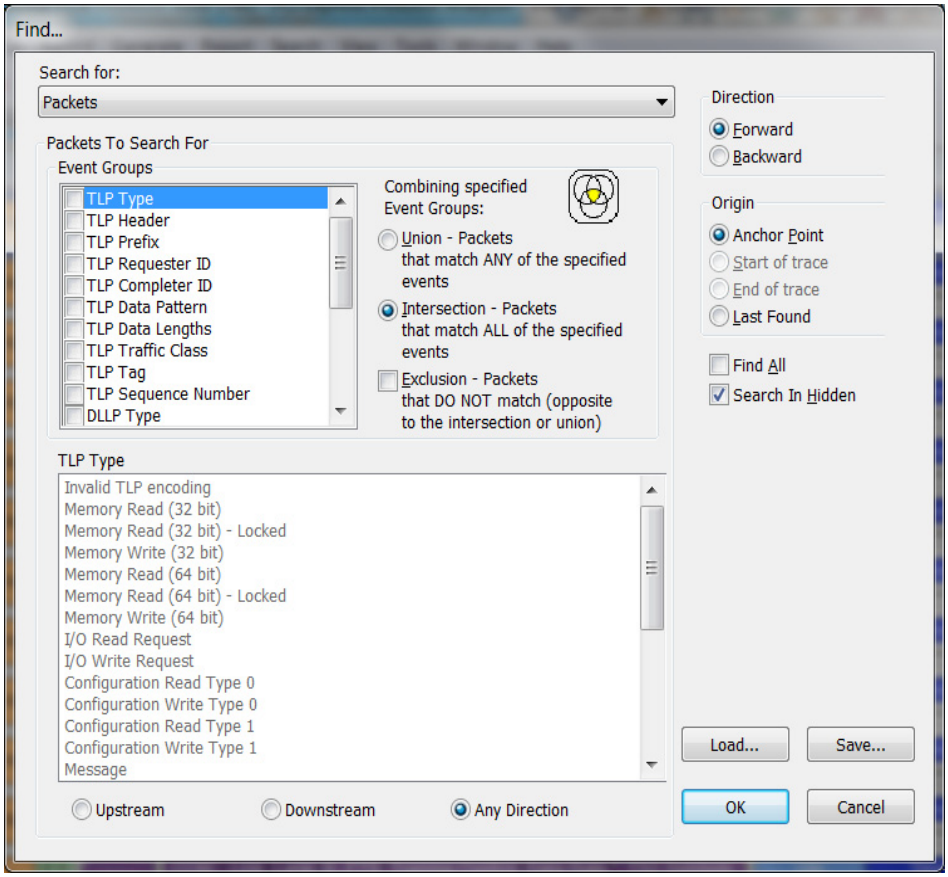
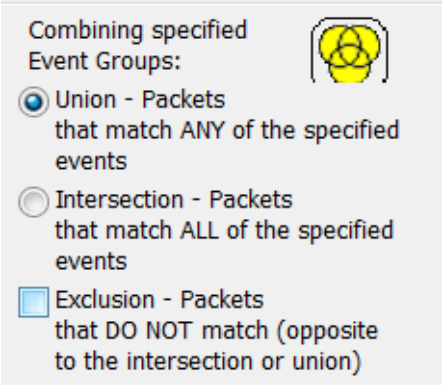


Figure 7.30: Find Dialog

3. From the Search For menu, select a display level such as **Packets**. To search multiple levels, finish steps 3 to 9, and then repeat 3 to 9 for each additional display level.
4. From the Event Groups menu, select an **Event Group**. The menu in the far right of the dialog is context sensitive and changes to reflect the options for that group.
5. In the menu in the far right, select one or more items.
6. Repeat Step 5 for each Event Group of interest for the selected display level.
7. Under Scope, select Current Segment or All Segments to reduce the scope of the search. This applies to old segmented traces, for newer traces leave this option in Current Segment.
8. Under Direction, select **Forward** or **Backward** to select a search direction.
9. Under Origin, select a starting point for the search.

10. Under **Combining Specified Event Groups**, select an option.



The options Union, Intersection, and Exclusion let you set conditions on your searches:

- **Union**: To search for **any** of the selected criteria.
  Example: “Find packets with ANY of the following characteristics …”
- **Intersection**: To search for **all** of the selected criteria.
  Example: “Find packets with ALL of the following characteristics …”
- **Exclude**: To **exclude** items from a search. This option works in conjunction with Union and Intersection. You select Union and Exclude to exclude any of the specified traffic. You select Intersection and Exclude to exclude all of the specified traffic.
  Example: “Exclude packets with ANY of the following …” or
  “Exclude packets with ALL of the following …”

11. Repeat Steps 3 through 9 for additional display levels.
12. **Find All** displays all matching packets or transactions in a separate view.
    NOTE: When **Find All** is checked, the reports display the information for the main trace, however, they do not include Search results.
13. **Search in Hidden** includes hidden packets or transactions in the search.
14. Click **OK**.

7.10.1 Event Groups for Packets

The Event Groups for Packets are:

- TLP Type
- TLP Header
- TLP Prefix
- TLP Requester ID
- TLP Completer ID
- TLP Data Pattern
- TLP Data Lengths
- TLP Traffic Class
- TLP Tag
- TLP Sequence Number
- DLLP Type
- DLLP Header
- DLLP Virtual Channel
- ACK/NAK Seq Number
- Ordered Sets
- Link Event
- OBFF Code
- Direction
- Errors
- TS1 Data (see “Find Next Packet Type” on page 569)
- TS2 Data (see “Find Next Packet Type” on page 569)
- Message Code

7.10.1.1 Example: TS1 and TS2 Event Groups

Selecting TS1 Data or TS2 Data options allows further definition of the exact field contents to match via the three dialogs show below. The search algorithm will find the specified TS ordered set on any lane.

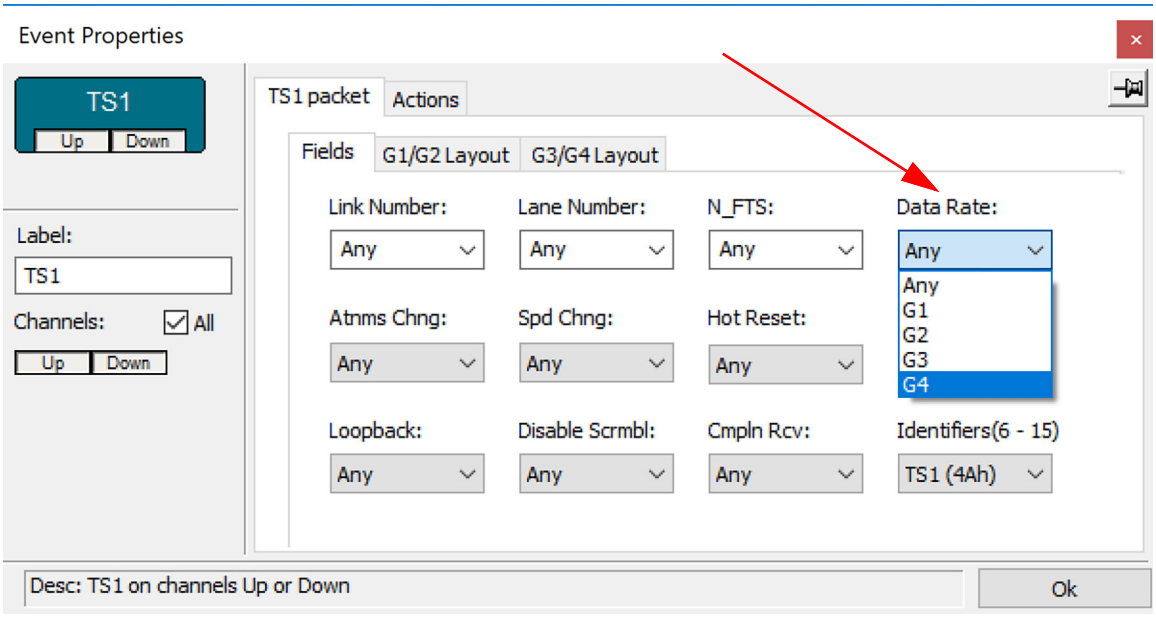


Figure 7.31: TS Data Fields Tab

Select parameters from the drop-down lists to use.

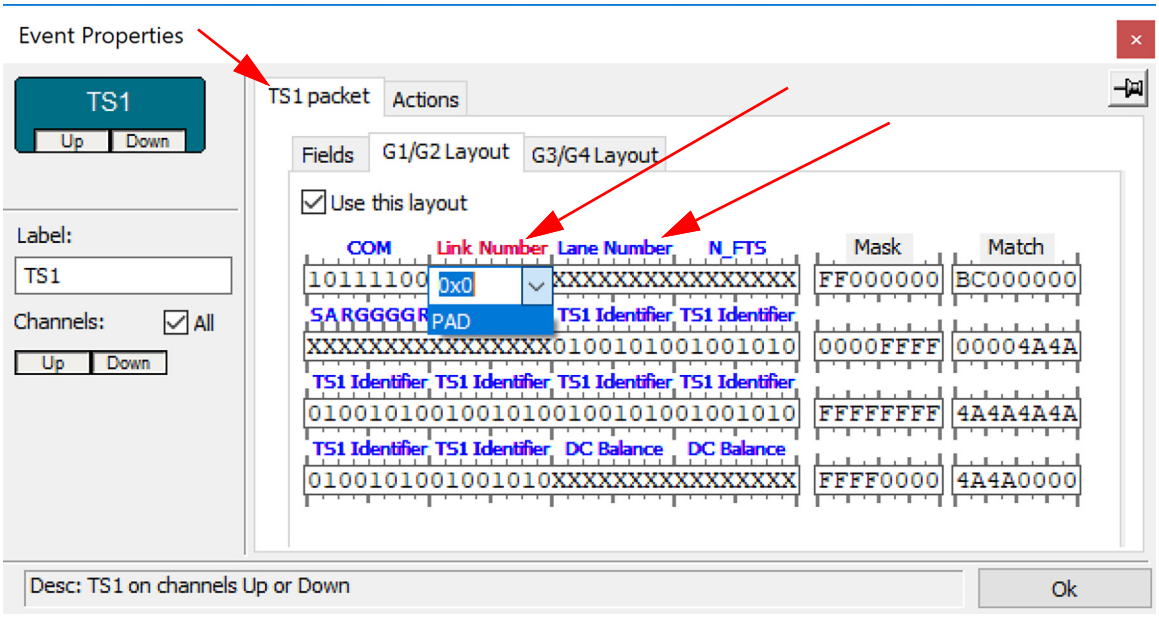


Figure 7.32: TS G1/G2 Layout Tab

Select parameters from the links to use and enter the mask and match values.

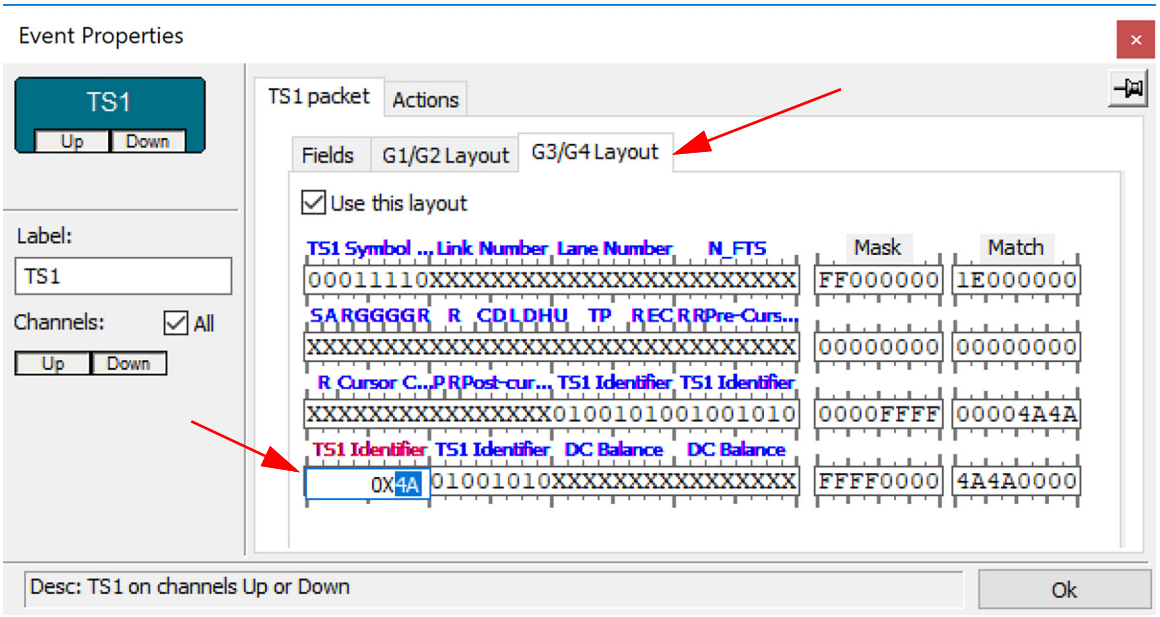


Figure 7.33: TS G3/G4 Layout Tab

Select parameters from the links to use and enter the mask and match values.

Example: TS1 Packet with G3 Speed and G3 Data Rate

In order to select TS1/TS2 packets for search/triggering on G3/G4 speed you need to set data for search/triggering to G3 (see Figure 7.34).

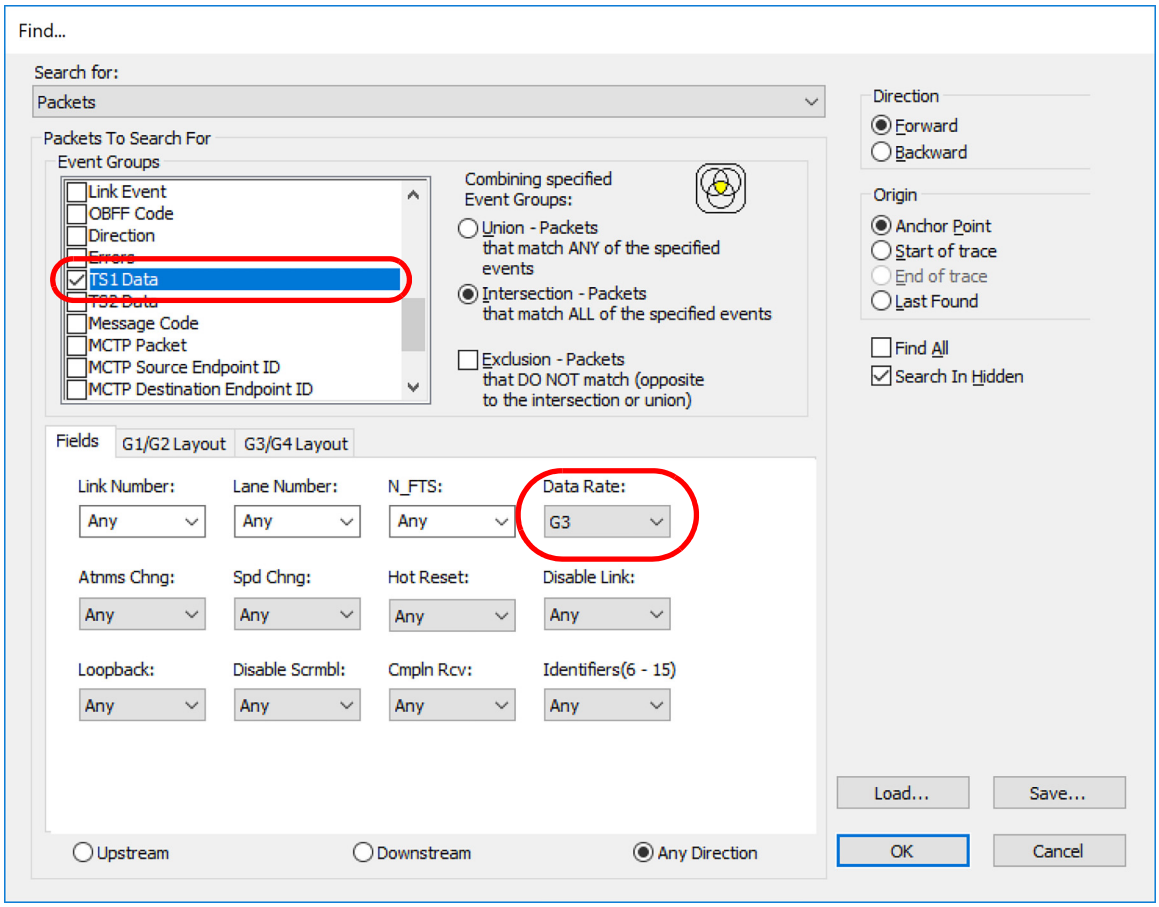


Figure 7.34: Set Search for: Packets -> TS1 Data and Data Rate G3

Set the Recording Options -> TS1 -> Event Properties with the same options. See Figure 7.35 on page 552.

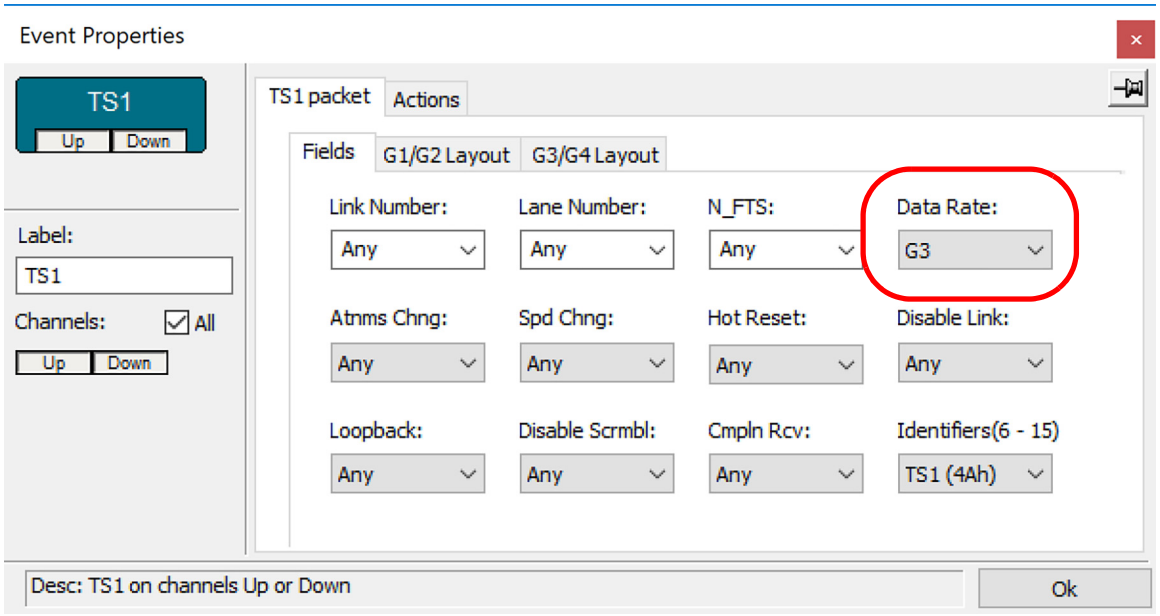


Figure 7.35: Recording Options: Event Properties -> TS1 Data Rate = G3

Uncheck the checkbox “Use this layout” in G1/G2 Layout tab (see Figure 7.36 on page 552).

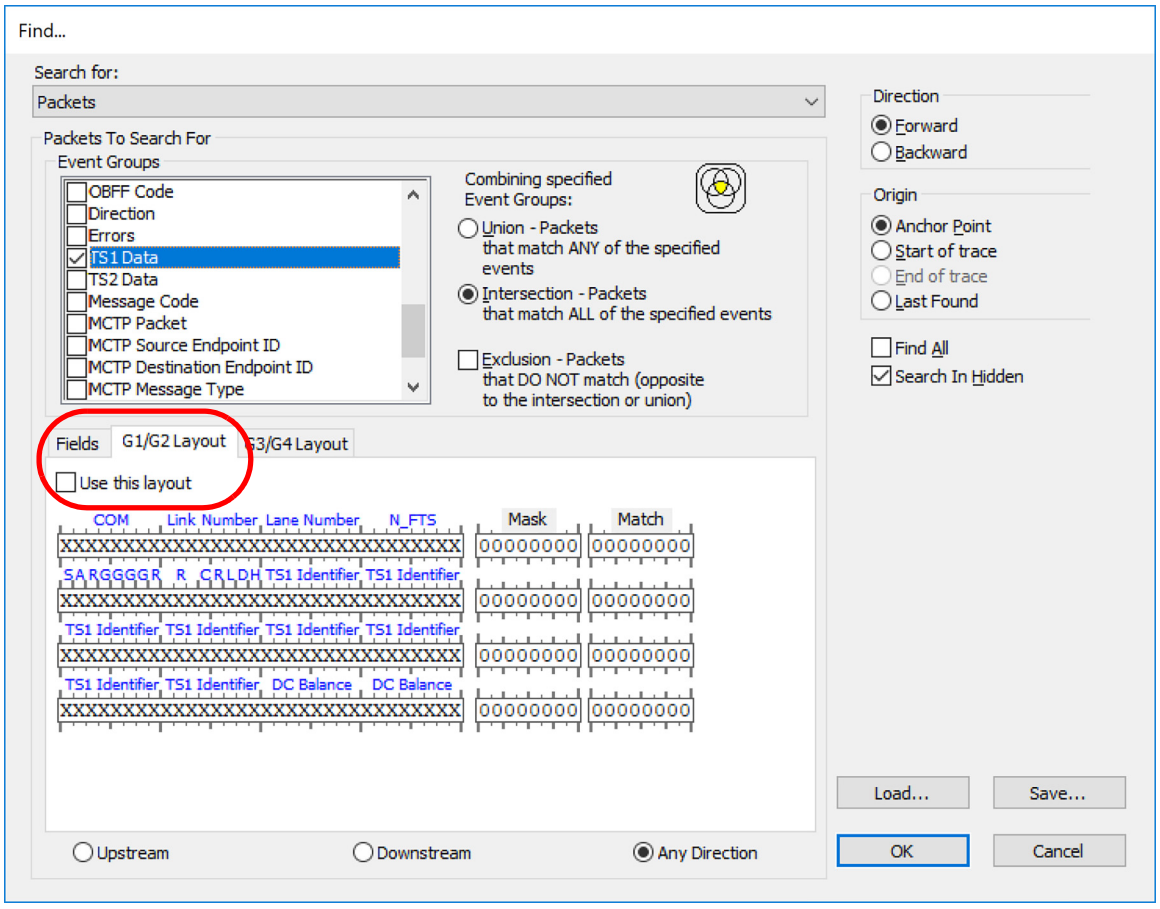


Figure 7.36: Find: Search for Packets -> TS1 G1/G2 Layout

Set the Recording Options -> TS1 packet -> Event Properties with the same options (see Figure 7.37).

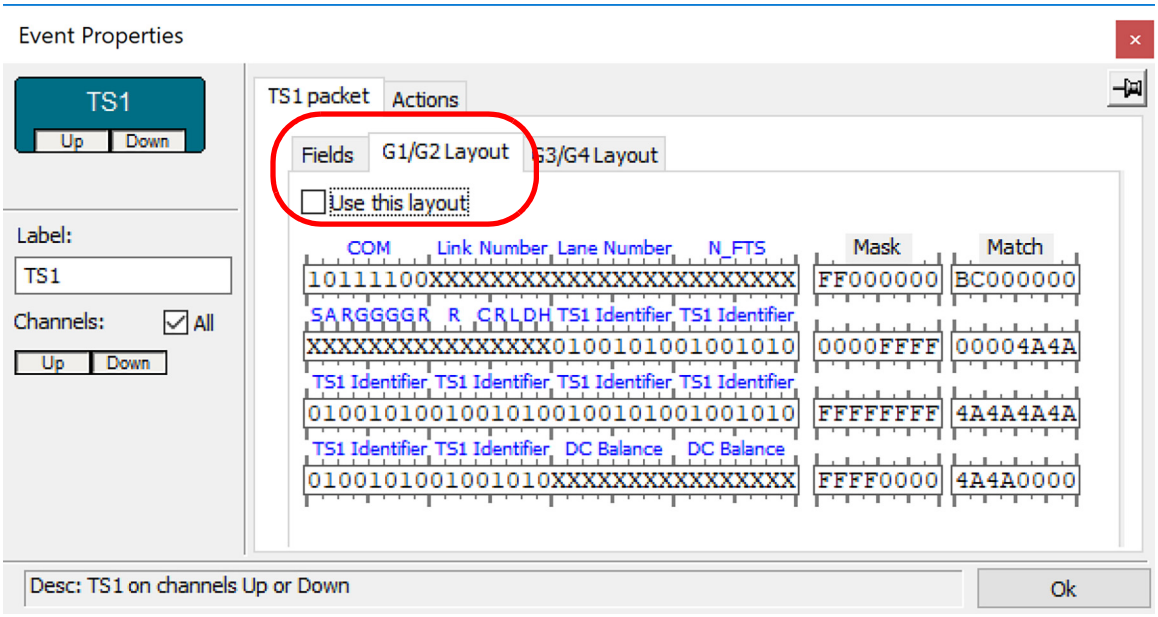


Figure 7.37: Set Recording Options: TS1 Event Properties

Keep the checkbox "Use this layout" in G3/G4 Layout tab checked. See Figure 7.38.

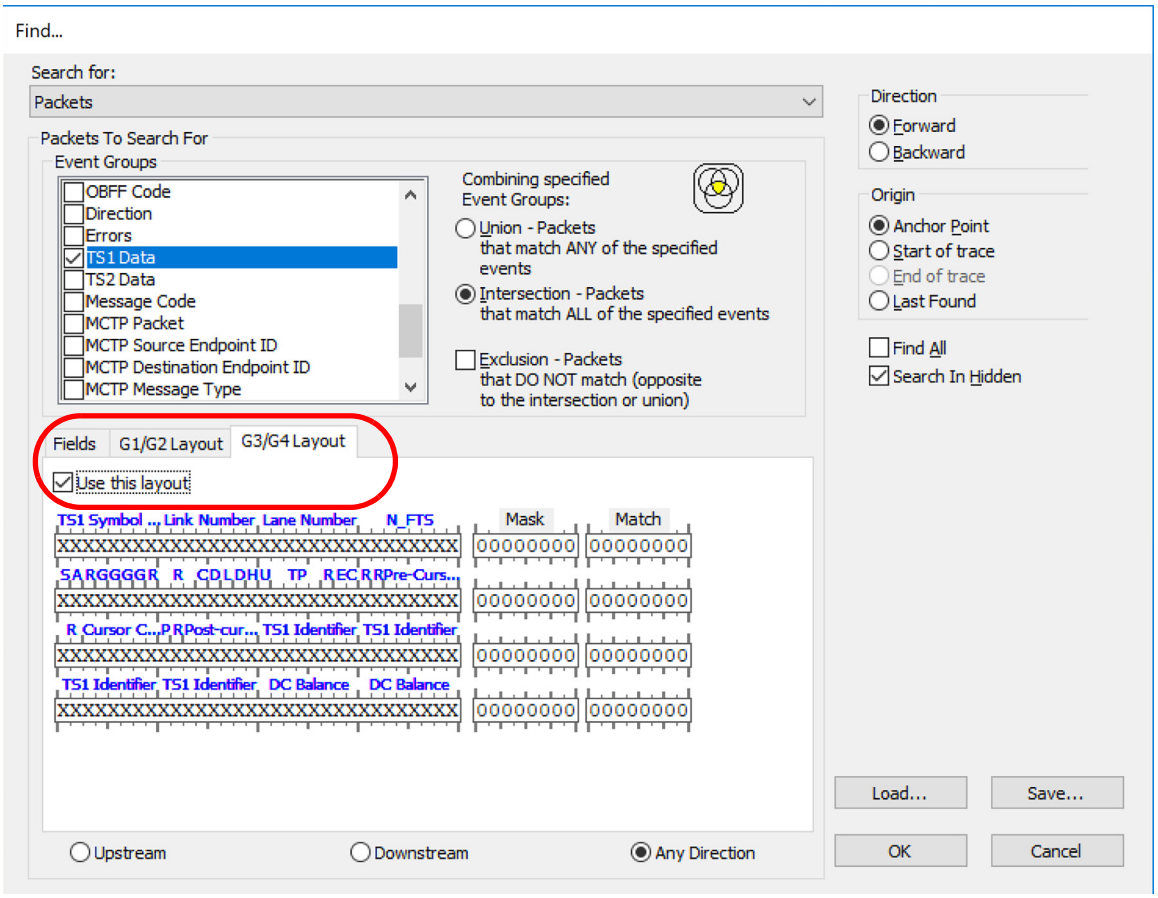


Figure 7.38: Find: TS1 Data -> G3/G4 Layout

Set the Recording Options, TS1 Event Properties with the same options. See Figure 7.39.

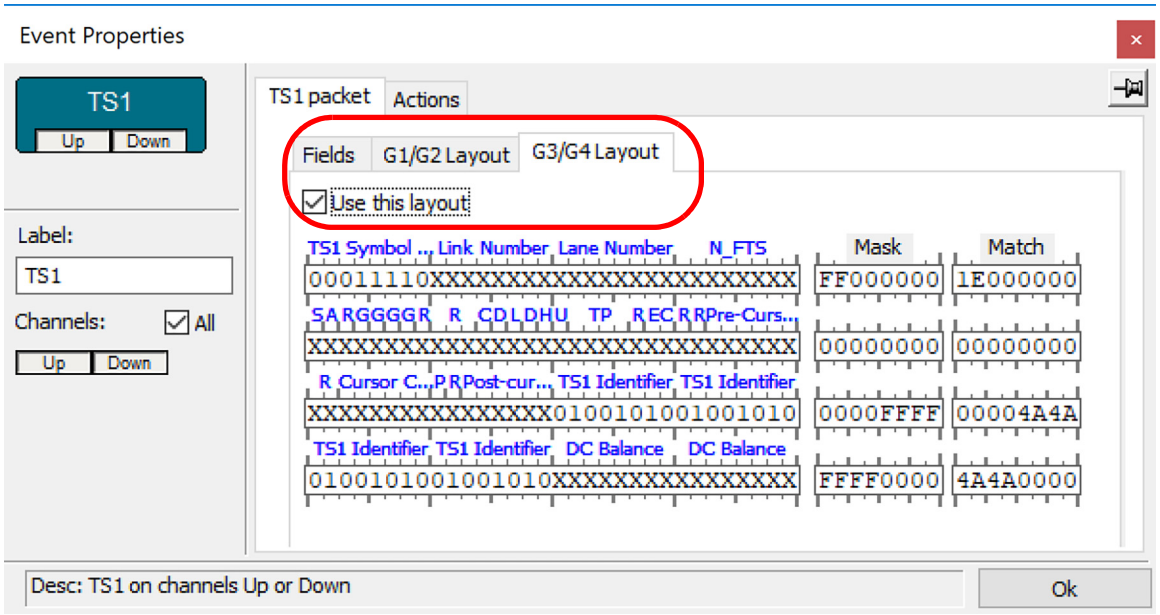


Figure 7.39: Recording Options; TS1 -> Event Properties

Search results example is shown in Figure 7.40.

Packet				Link	Lane	N_FTS	Training Control	Data Rate	Eq Control	P
35387737	R←	8.0 x4	TS1	0	*	252	0 0 0 0 0	2.5 GT/s, 5.0 GT/s, 8.0 GT/s	0 0 7 0	
35387738	R←	8.0 x4	TS1	0	*	252	0 0 0 0 0	2.5 GT/s, 5.0 GT/s, 8.0 GT/s	0 0 7 0	
35387739	R←	8.0 x4	TS1	0	*	252	0 0 0 0 0	2.5 GT/s, 5.0 GT/s, 8.0 GT/s	0 0 7 0	
35387740	R←	8.0 x4	TS1	0	*	252	0 0 0 0 0	2.5 GT/s, 5.0 GT/s, 8.0 GT/s	0 0 7 0	
35387741	R←	8.0 x4	TS1	0	*	252	0 0 0 0 0	2.5 GT/s, 5.0 GT/s, 8.0 GT/s	0 0 7 0	
35387742	R←	8.0 x4	TS1	0	*	252	0 0 0 0 0	2.5 GT/s, 5.0 GT/s, 8.0 GT/s	0 0 7 0	
35387743	R←	8.0 x4	TS1	0	*	252	0 0 0 0 0	2.5 GT/s, 5.0 GT/s, 8.0 GT/s	0 0 7 0	
Packet	R←	8.0	TS1	Link	Lane	N_FTS	Training Control	Data Rate	Eq Control	P

Figure 7.40: Example of Finding TS1 Packet with G3 Speed and G3 Data Rate

Example: TS1 Packet with G1 Speed and G3 Data Rate

In order to select TS1/TS2 packets for search/triggering on G1/G2 speed you need to set the data rate for searching/triggering to G3. See Figure 7.41.

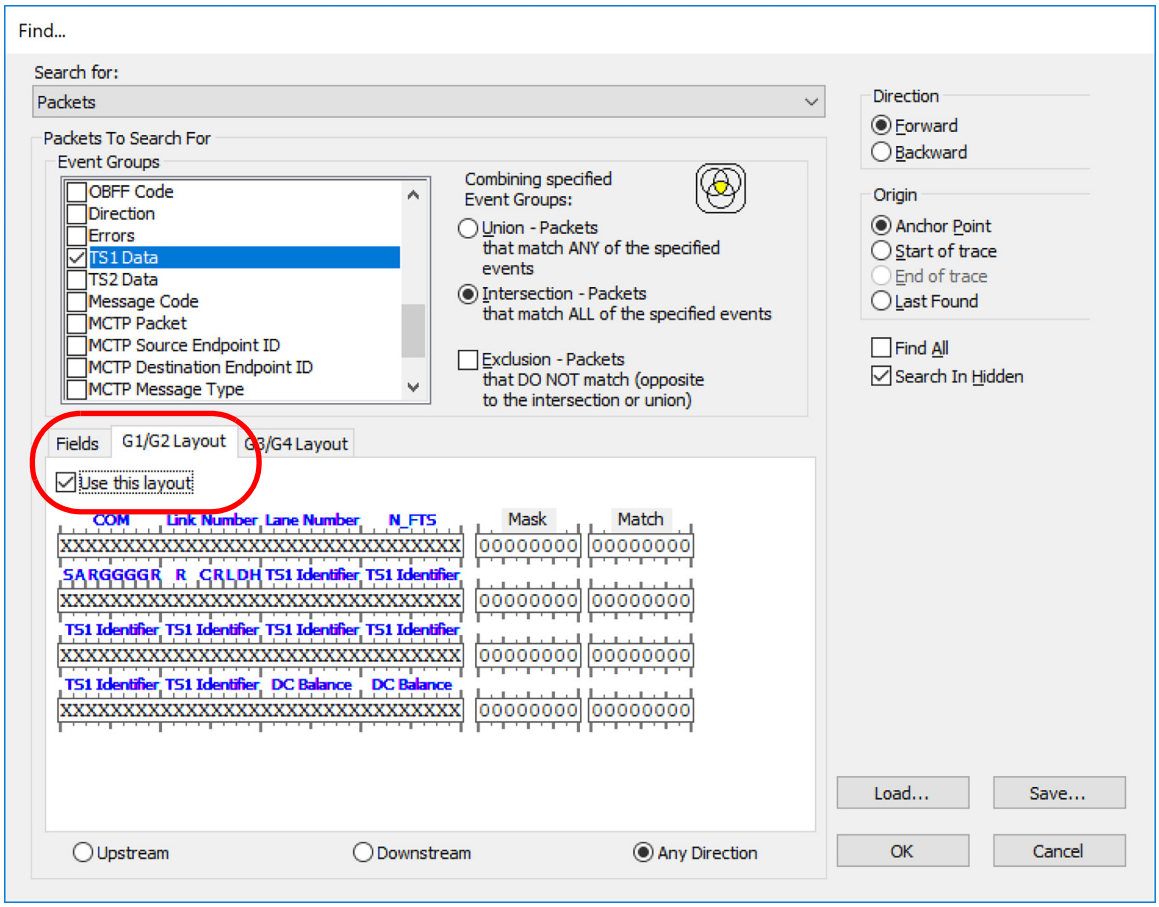


Figure 7.41: Find: TS1 Data -> G1/G2 Layout

Set the Recording Options with the same options. See Figure 7.42 on page 556.

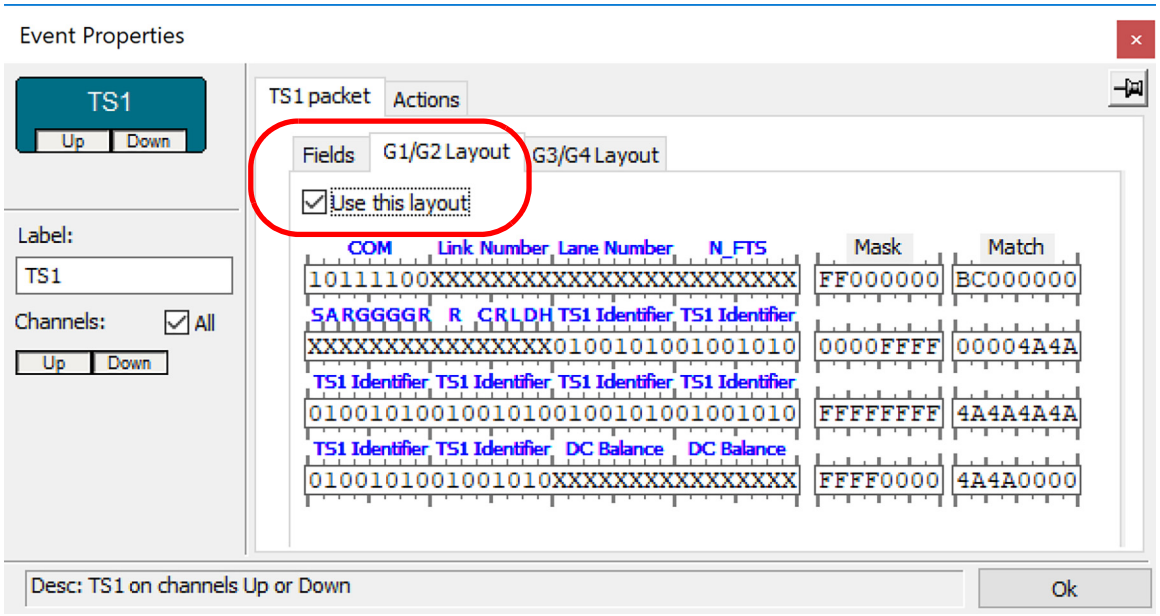


Figure 7.42: Recording Options: TS1 -> Event Properties

Uncheck the checkbox “Use this Layout” in the G3/G4 tab in the Find -> Search for dialog box. See Figure 7.43.

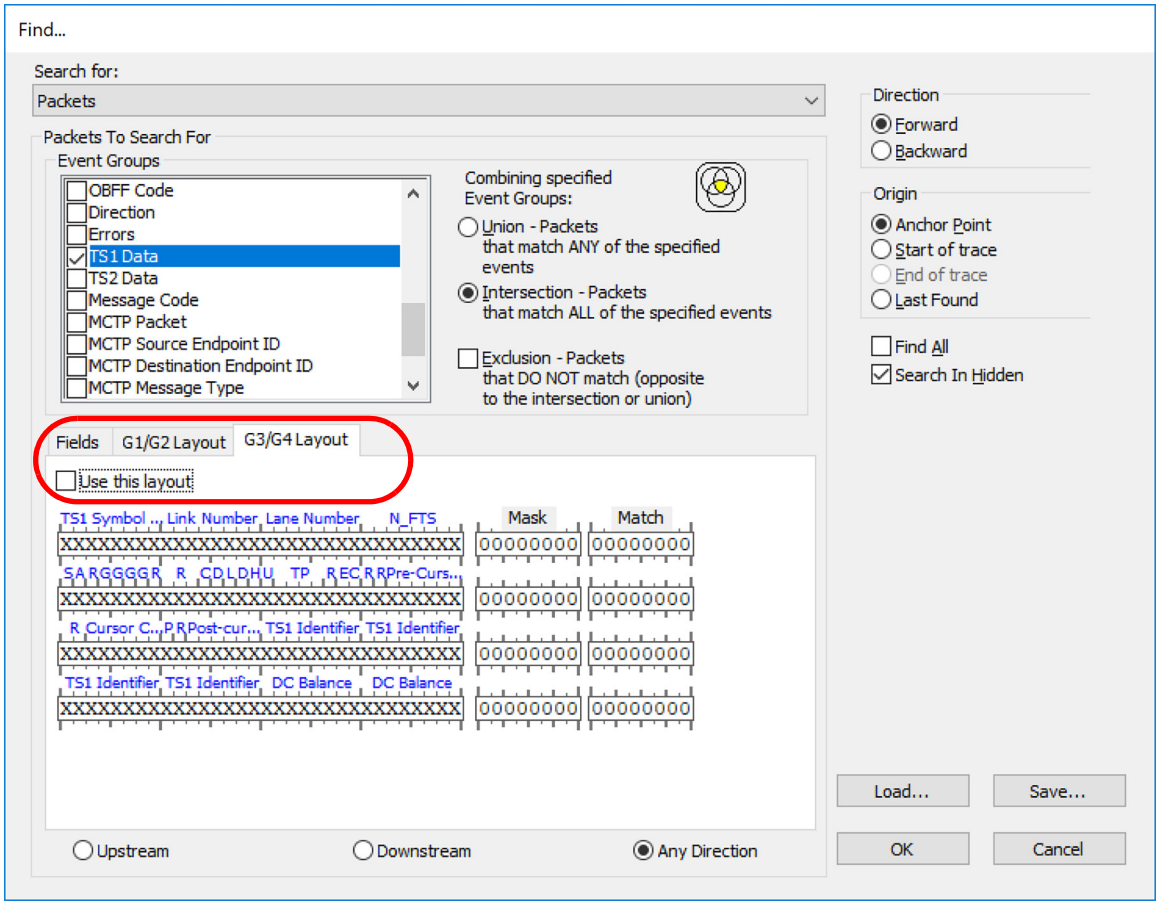


Figure 7.43: Find: TS1 Data -> G3/G4 Layout

In a similar fashion uncheck the checkbox in Recording Options, TS1, Event Properties. See Figure 7.44.

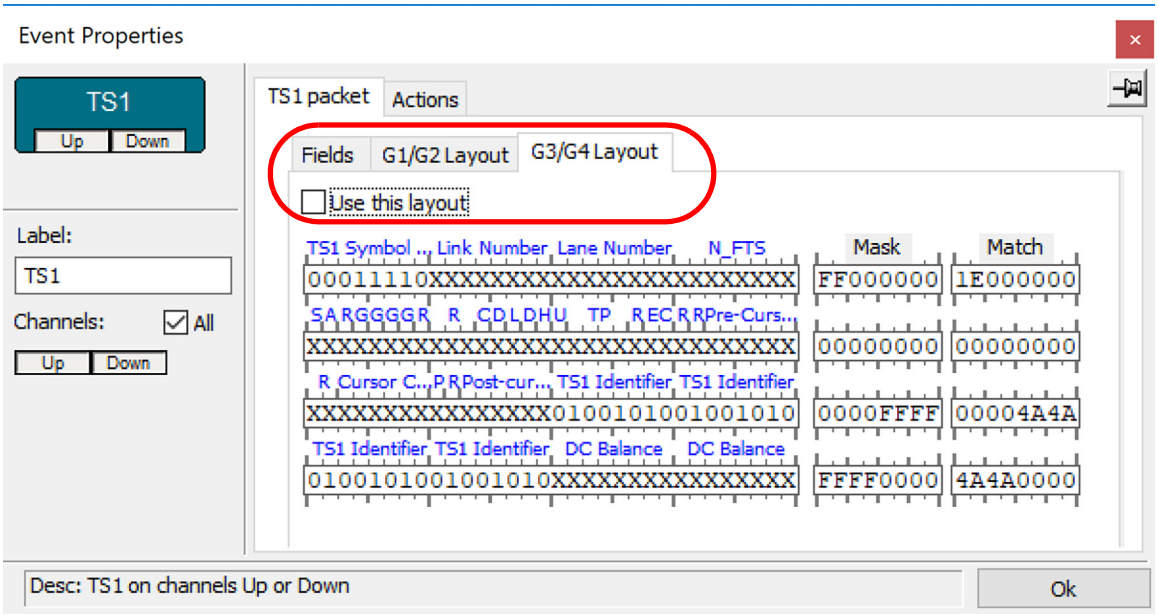


Figure 7.44: Recording Options: TS1 -> Event Properties

An example of a captured trace with TS1 at G1 speed and Data at Gen3 Data Rate is shown below. See Figure 7.45.

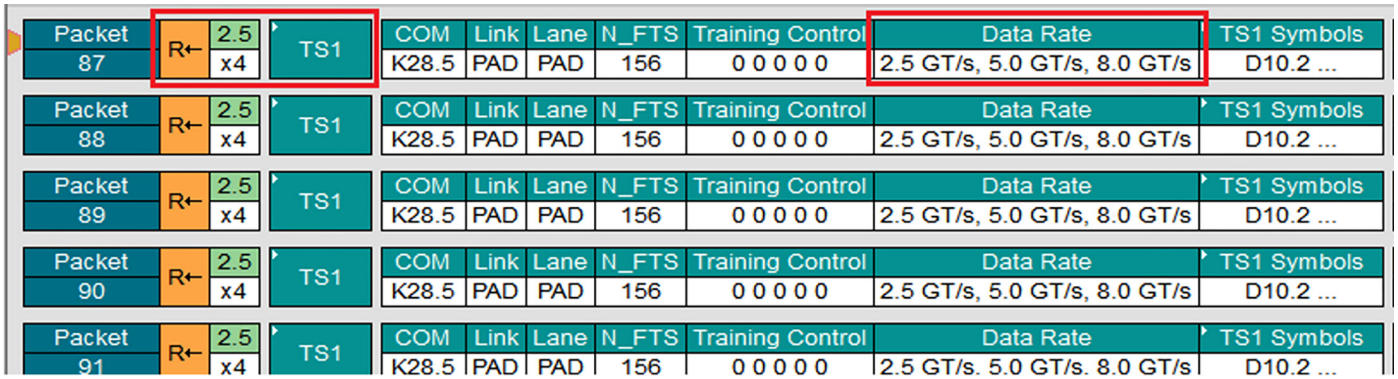


Figure 7.45: TS1 Packet with G1 Speed and G3 Data Rate

Example: Search for PMUX Channel ID

In this case, we are searching for the following event:

PMUX Channel ID (see Figure 7.46)

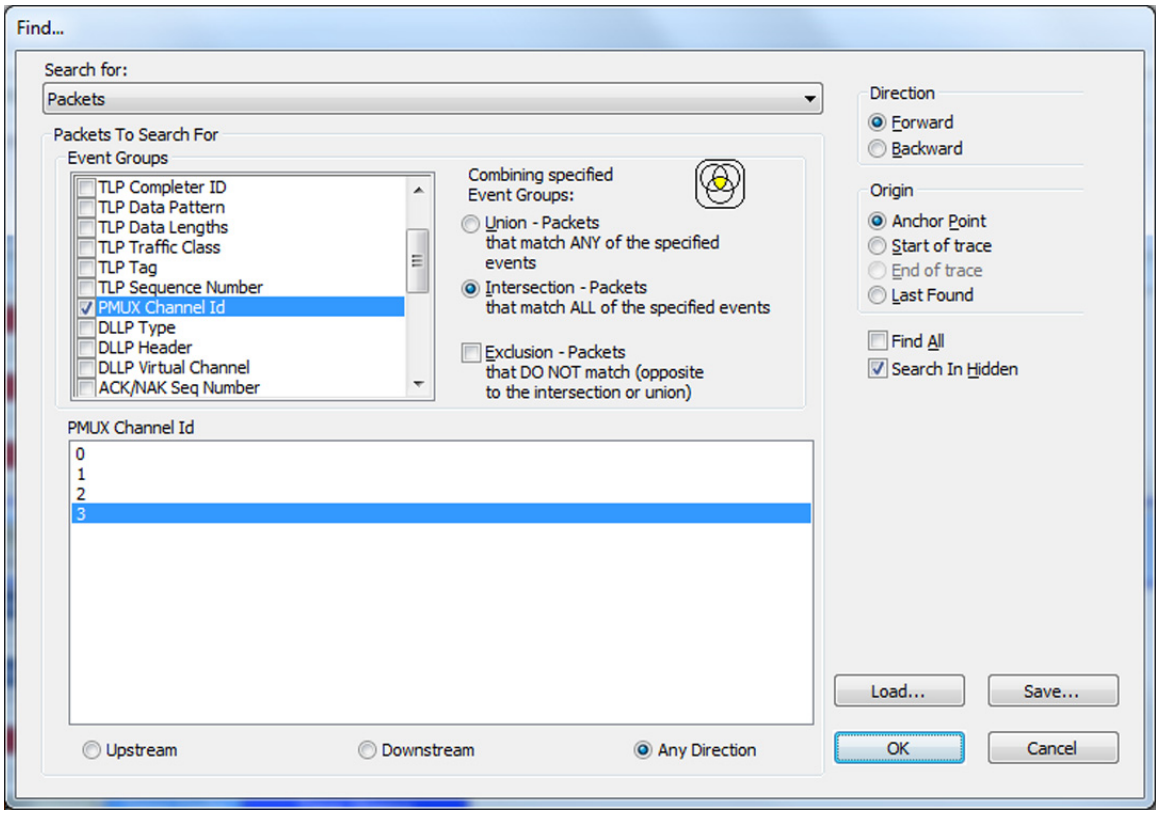


Figure 7.46: Search for: PMUX Channel ID (3)

PMUX Channel ID Found and PMUX Packet Error Decoded in Trace

In the trace both the PMUX Channel ID was found and a Packet PMUX Error was decoded. See Figure 7.47.

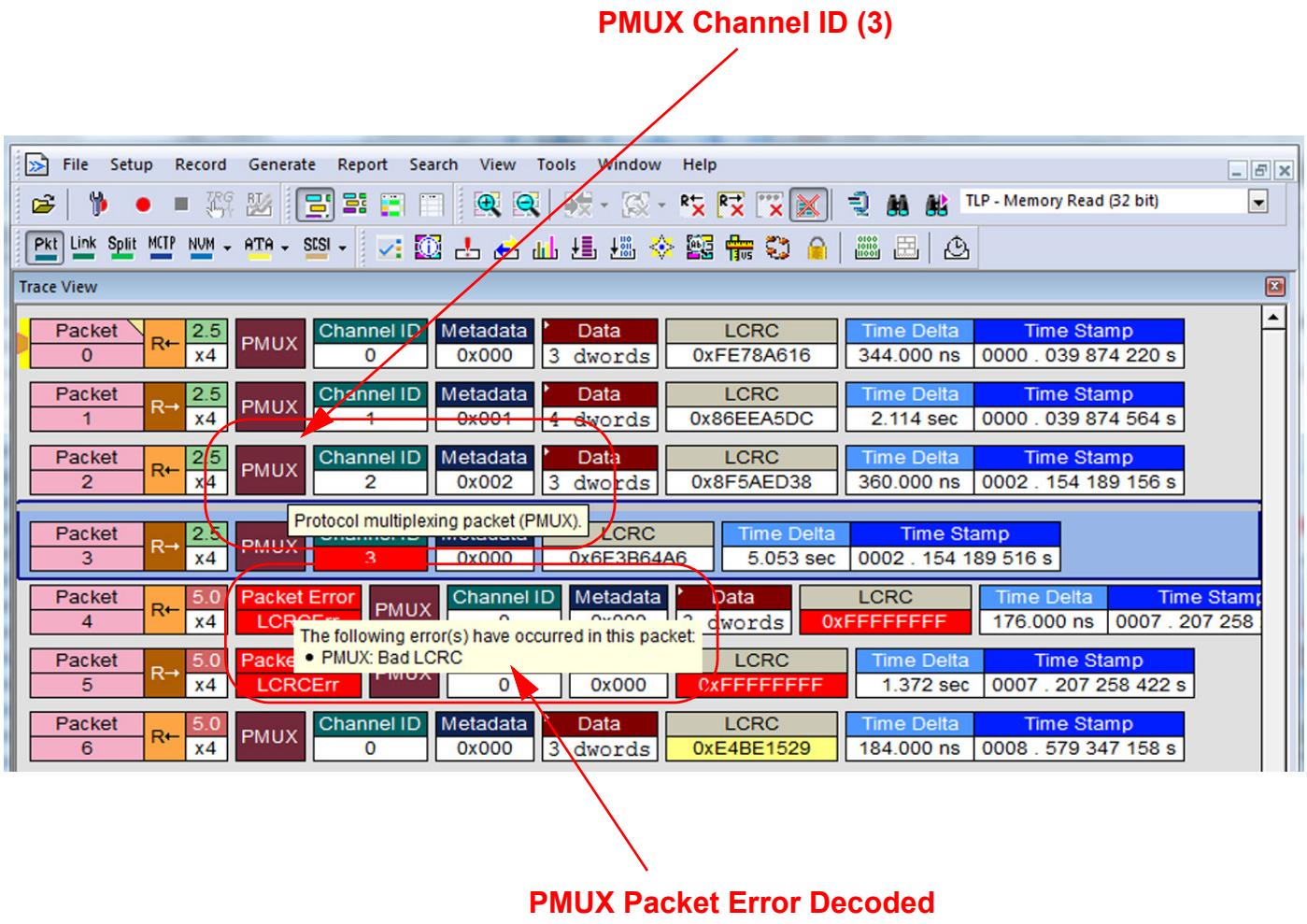


Figure 7.47: PMUX Channel ID (3) Found in Trace and Packet Error Decoded

7.10.2 Event Groups for Link Transactions:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- RequesterID
- CompleterID
- Status
- Tag

7.10.3 Event Groups for Split Transactions:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- Requester ID
- Completer ID
- Status
- Tag
- Address

7.10.4 Event Groups for NVMe transactions:

- Controller Registers
- Other NVMe Entities
- Queue IDs
- Command IDs
- Doorbell Registers
- Admin Submission Command Set
- NVMe Submission Command Set
- Completion Queue Entry
- PRP
- Submission Command
- NVMe Errors

7.10.5 Event Groups for PQI Transactions:

- PQI Register ID
- PQI Admin Functions
- PQI Errors

7.10.6 Event Groups for AHCI Transactions:

- AHCI Register ID
- AHCI Port Number
- AHCI Slot Number
- AHCI Port Multiplier Port
- AHCI Raw Address
- AHCI Direction
- AHCI Errors

7.10.7 Event Groups for ATA transactions:

- ATA Register Type
- ATA Port Number
- ATA Slot Number
- ATA Raw Address
- ATA Port Multiplier Port
- ATA Interruption Reason
- ATA Error Type
- ATA Input/Output
- ATA Payload Portion
- ATA CFIS Fields
- ATA RFIS Device to Host Fields
- ATA DSFIS Fields
- ATA PSFIS Fields
- ATA SDBFIS Fields

7.10.8 Event Groups for SOP Transactions:

- SOP Information Unit ID
- SOP Errors

7.10.9 Event Groups for SCSI Transactions:

- SCSI Commands
- Command Status
- Task Managements
- Task Management Responses
- Errors
- SCSI Logical Unit Numbers

7.10.10 Event Groups for NVMe Commands:

- Admin Command Set
- NVM Command Set
- Submission QID
- Completion QID
- Status
- Errors
- LBA
- NVM Command
- NVM Payload Portion
- TCG Types
- TCG Method
- TCG Invoker
- TCG Com ID
- TCG Ext Com ID
- RPMB

Note: When searching for a LBA range, it find commands with LBAs that intersect with the selected address range.

Example: Search for NVMe Command

In this case, we are searching for the following event (see Figure 7.48 on page 563):

- NVMe Command
- Event Group NVM command
- Command = 0x02, Read
- Value = 1
- Fields = SQID [SELECTED: 1]

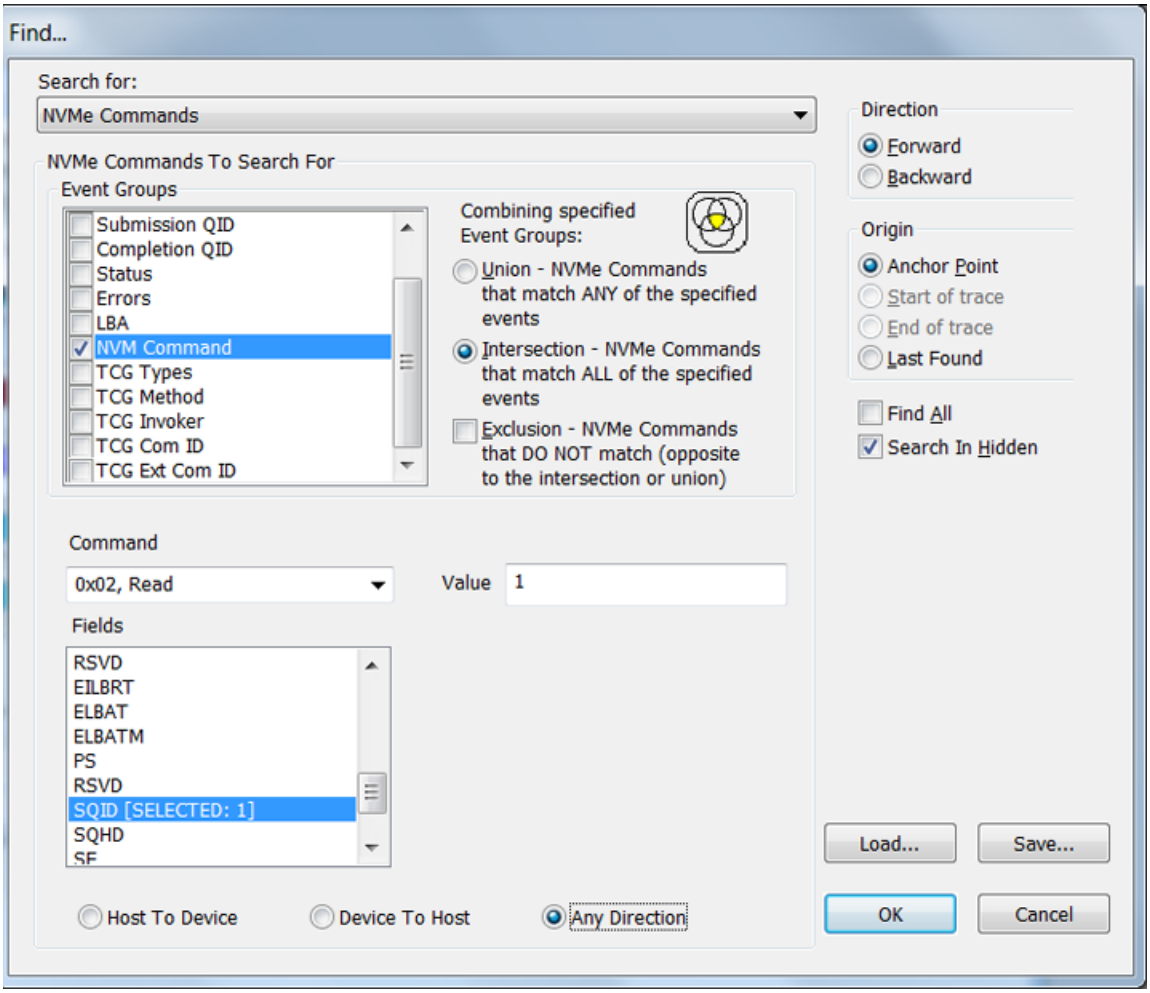


Figure 7.48: Find: Search for NVMe Command

Select OK.

Figure 7.49 shows that NVMe Command #67 is a Read Command that has an SQID value of 1.

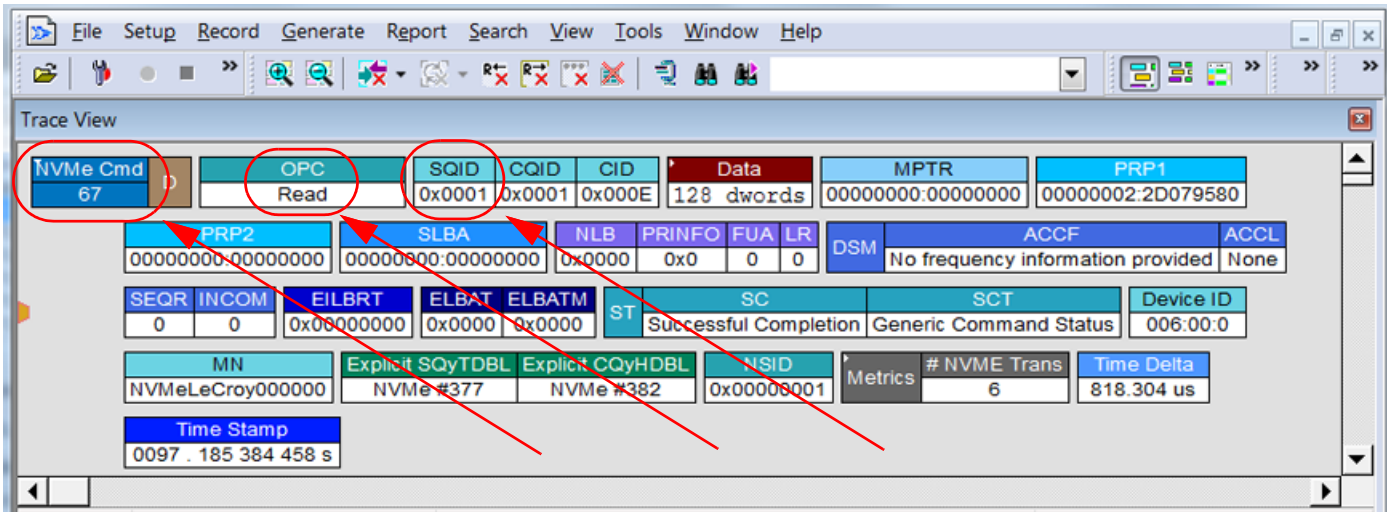


Figure 7.49: Find => Search for NVMe Command => Found

Example: Search for NVMe Command: NVM Payload Portion

The Find -> Search for: NVMe Commands -> Event Groups -> NVM Payload Portion will search the currently loaded trace for an NMV Payload. See Figure 7.50.

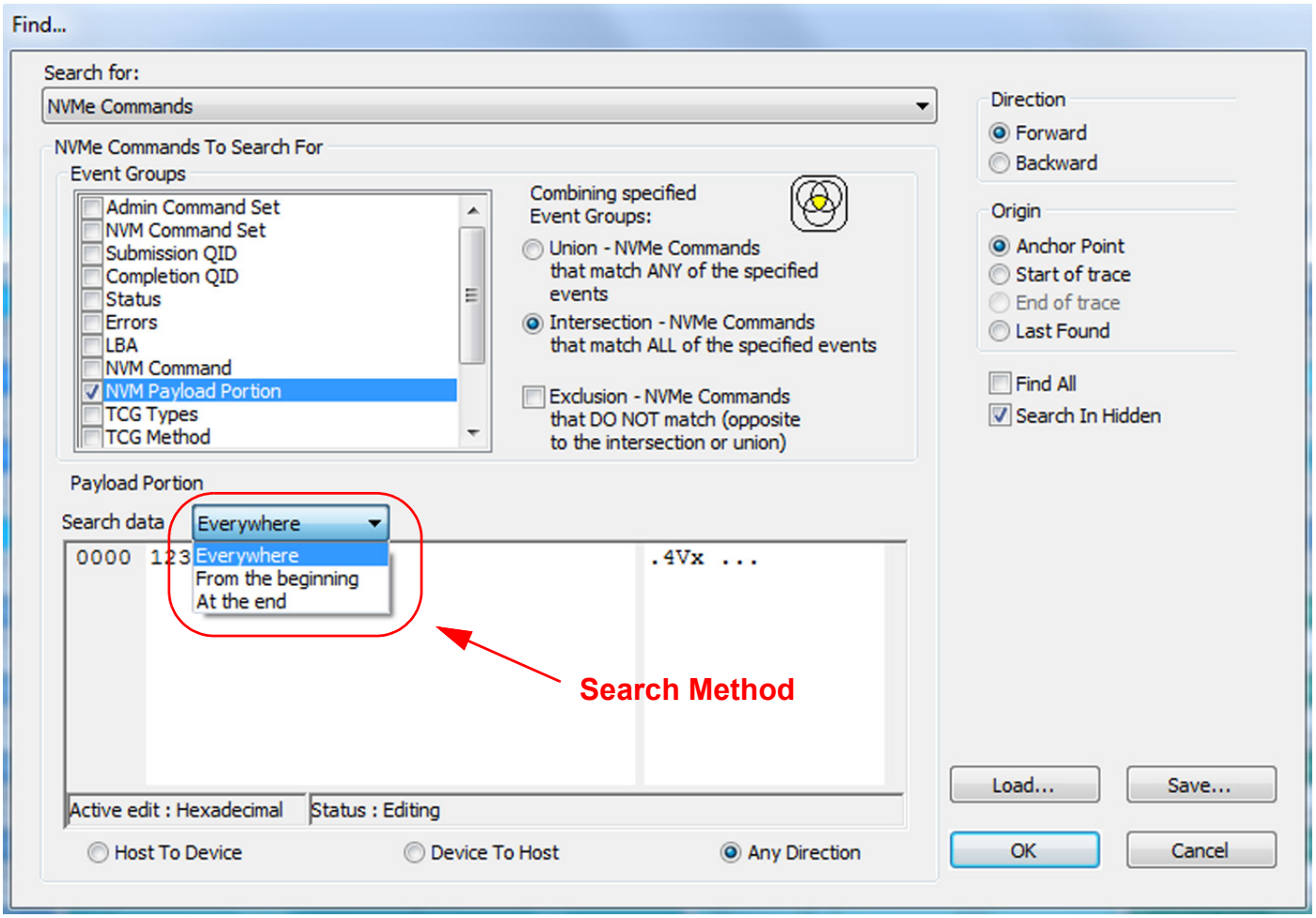


Figure 7.50: Find: Search for NVMe Commands -> NVM Payload Portion

There are several methods which can be used to search the NVM Payload for a particular data pattern:

- Everywhere - matching the set pattern anywhere in the payload
- From the beginning - matching the set pattern in the payload at offset 0
- At the end - matching the set pattern with the offset calculated by the length of the pattern from the end of the payload.

The different search methods are illustrated in Figure 7.51 on page 565.

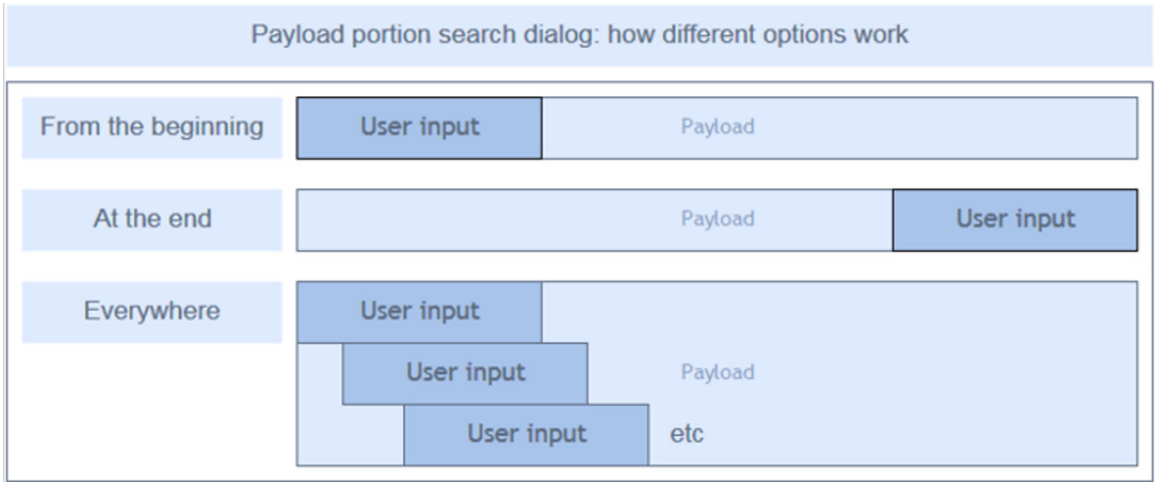


Figure 7.51: Search NVM Payload: Different Methods

7.10.11 Event Groups for MCTP Messages:

- MCTP Message Type
- MCTP Control Command Code
- MCTP Control Completion Code
- MCTP Control Instance ID
- MCTP Error
- PLDM Type
- PLDM Command Code
- PLDM Completion Code
- NCSI Command
- NCSI Response
- NCSI AEN Type

Example: MCTP Messages to Search For

The Event Groups for MCTP Messages are:

- MCTP Message Type
- MCTP Control Command Code
- MCTP Control Completion Code
- MCTP Control Instance ID

You can search for a number of MCTP Messages -> Event Groups -> MCTP Control Command Codes. See Figure 7.52.

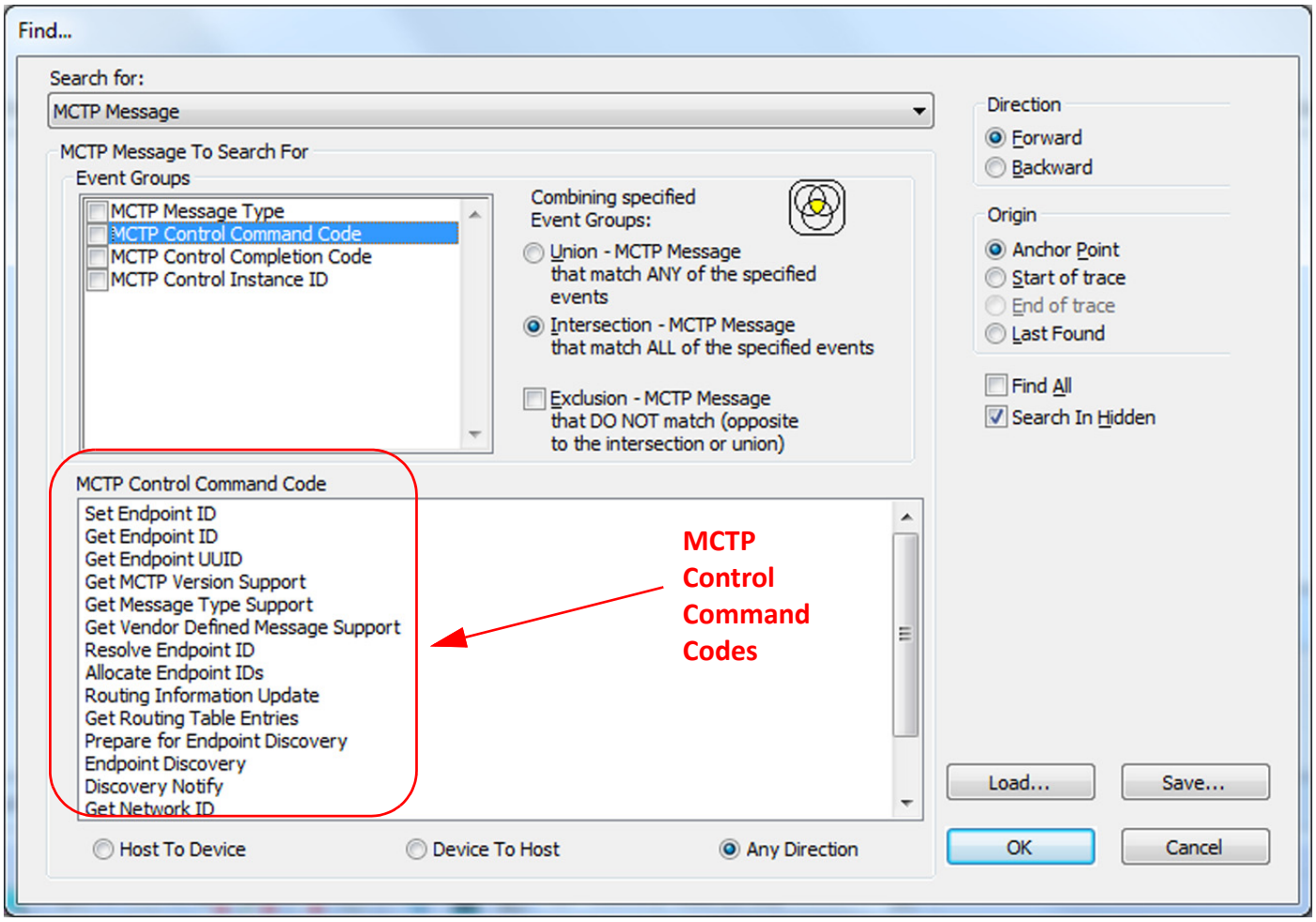


Figure 7.52: Search for MCTP Messages

Example: Searching for PLDM Message Types within MCTP Messages

You can search for the following PLDM Message Types within an MTCP Message:

- PLDM Type
- PLDM Command code
- PLDM Completion code

See Figure 7.53.

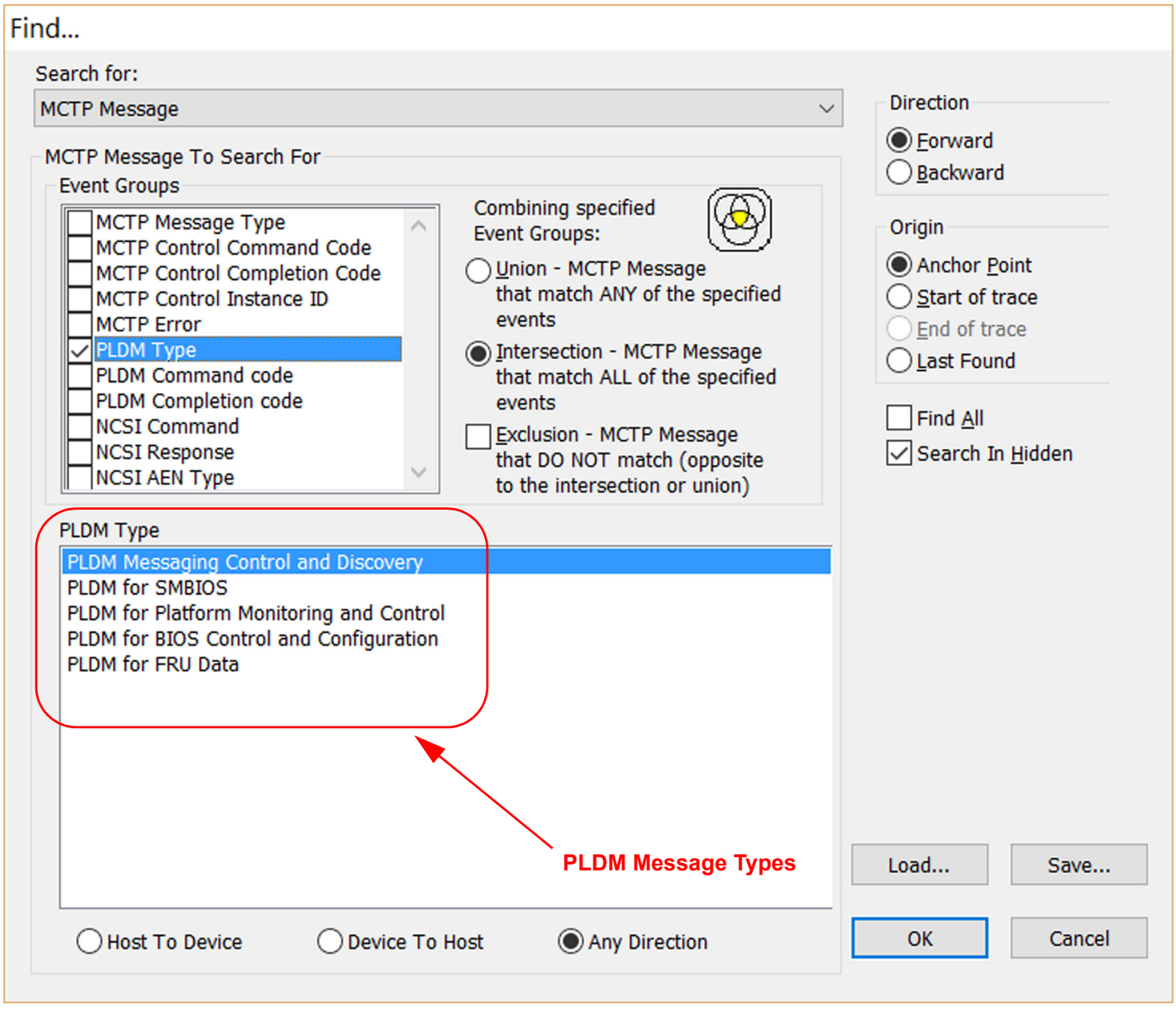


Figure 7.53: Search for PLDM Message Types with MCTP Message

Example: Searching for NC-SI Message Types within MCTP Messages

You can search for the following NC-SI Message Types within an MTCP Message:

- NCSI Command
- NCSI Response
- NCSI AEN Type

See Figure 7.54.

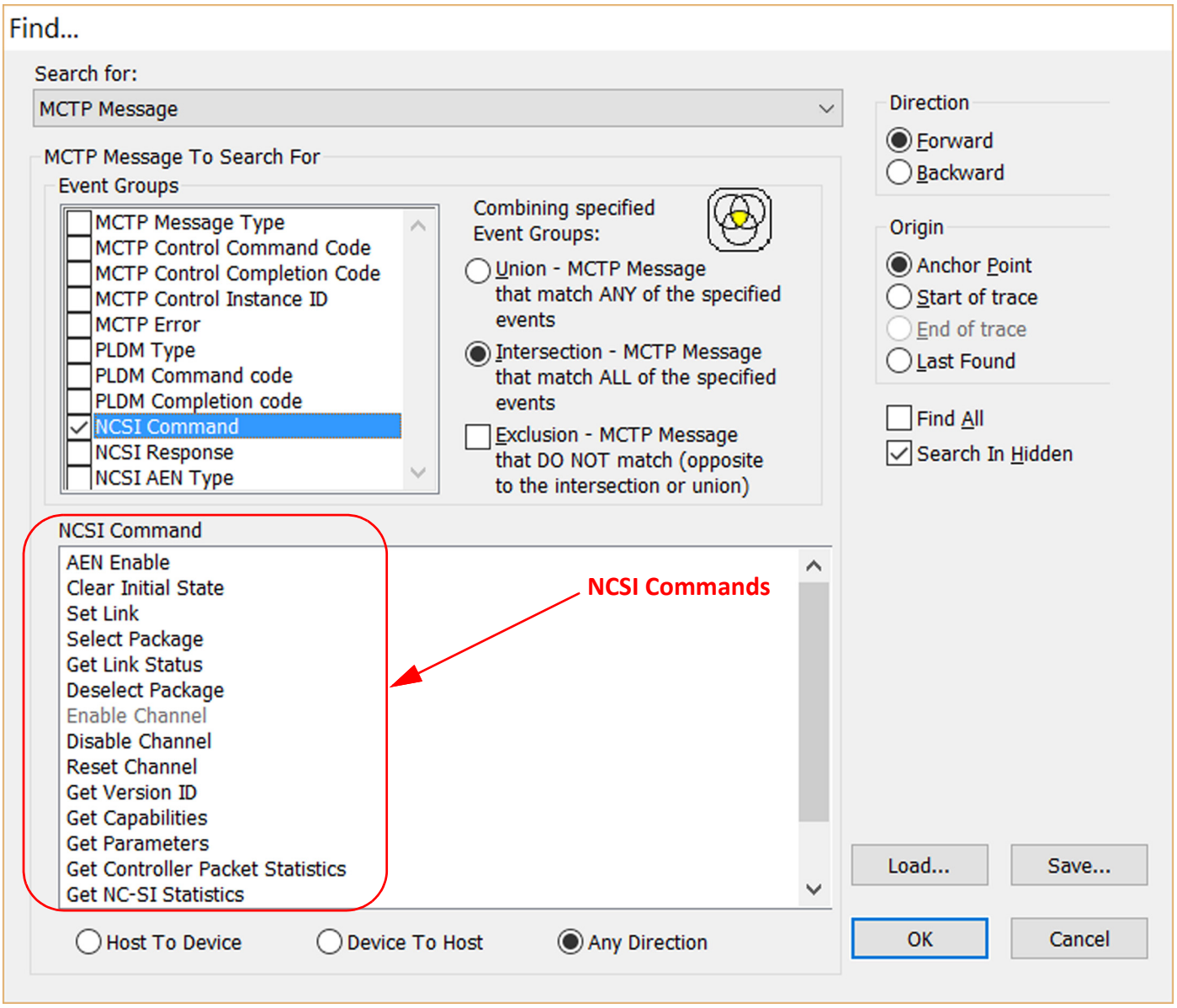


Figure 7.54: Searching for NC-SI Message Types within an MCTP Message

7.11 Find Next Packet Type

Use Find Next or click  to search for the next packet meeting the search criteria.

7.11.1 Example: Quick Search Feature

As an example, the NVMe_Z3DriveEmulation Trace has been loaded from the C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\Sample Files (see Figure 7.55).

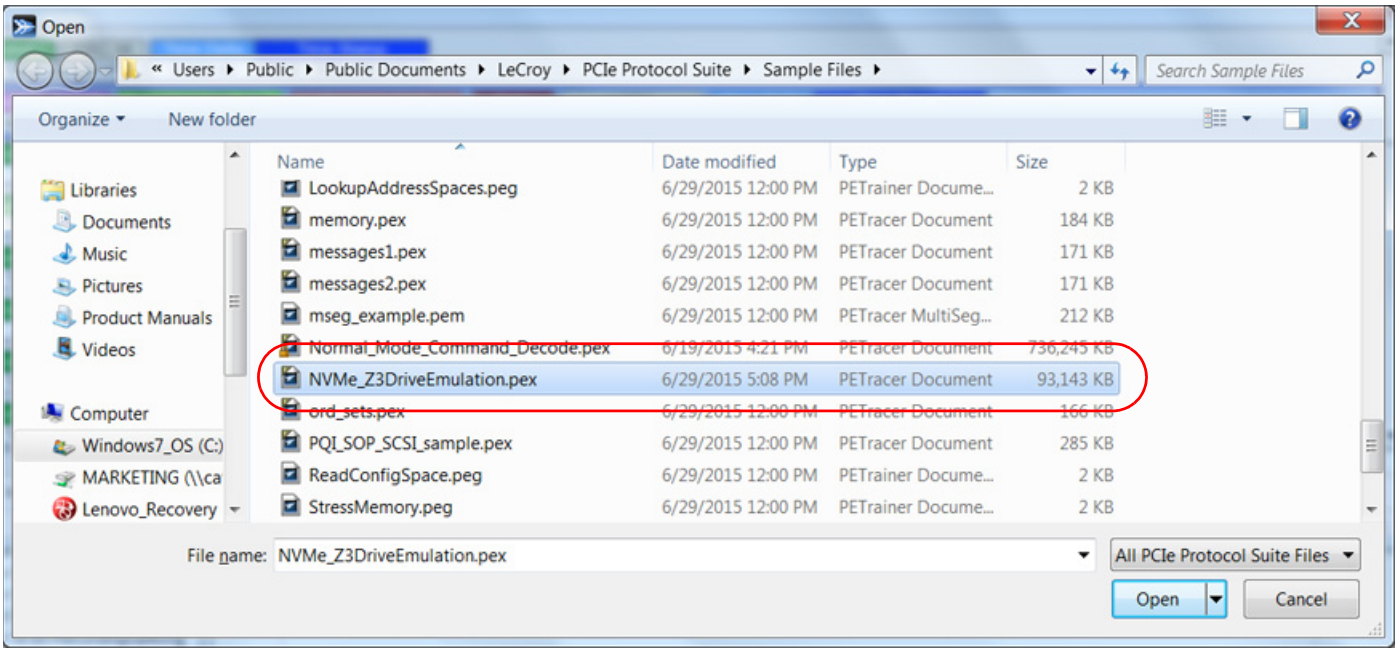


Figure 7.55: Location of Trace File to be Loaded

Select the NVMe_Z3DriveEmulation.pex file and click on Open.

The Main Menu will look like Figure 7.56 after you chosen to look for NVMe commands and removed unrelated traffic.

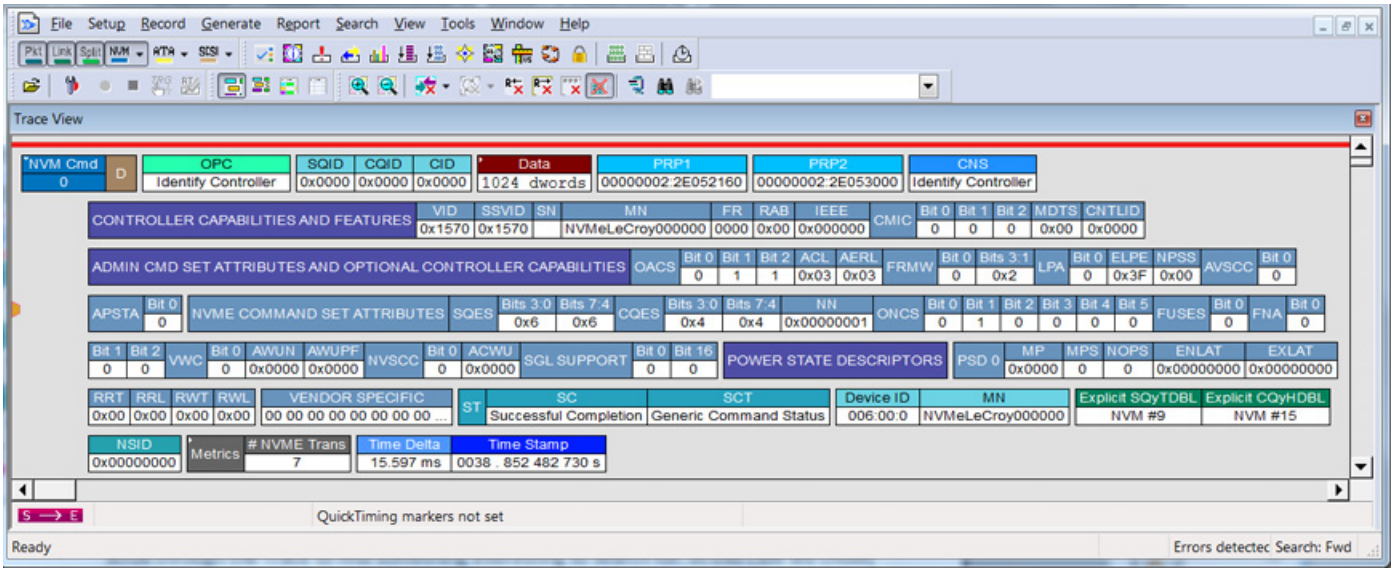


Figure 7.56: Main Menu with NVMe_Z3DriveEmulation Trace Loaded

Enter a term to search for in the Search Window.

In this case, we chose “NVM #66 

.

Place the cursor inside the Search Window and click the Enter key. The results are shown below (see Figure 7.57).

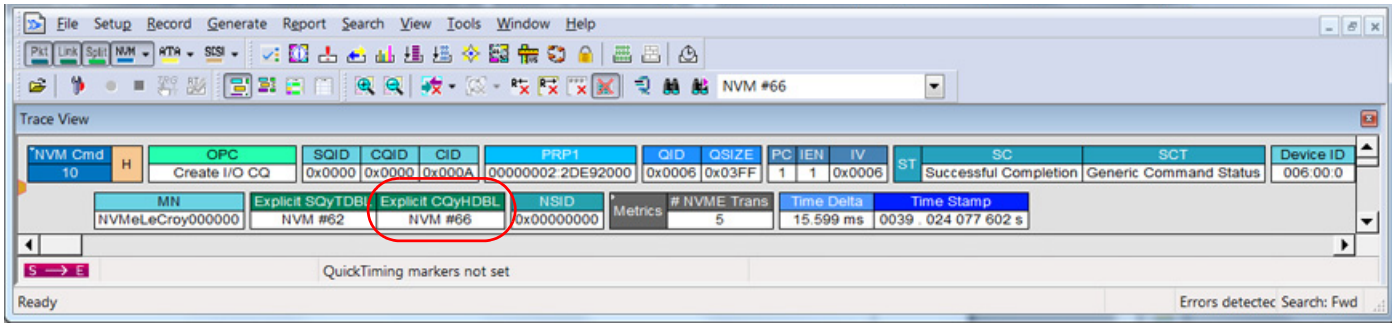


Figure 7.57: Search for NVM #66

Once the packet in the Trace has been found, the NVM #66 can be seen to be part of a doorbell event (Explicit SQyTDBL: NVM #62 with the response of Explicit CQyHDBL NVM #66).

This was just an example, you can search for any of the pre-defined terms (Figure 4.11 on page 178) or chose your own term or event to search for.

If you started Searching in the middle of the Trace the following windows will pop up:

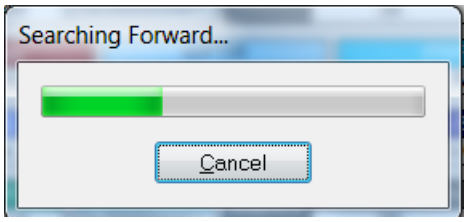


Figure 7.58: Search Progress Window

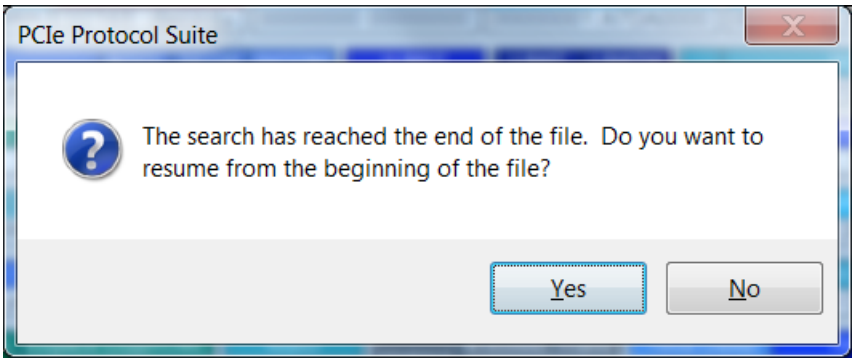


Figure 7.59: Resume Searching From Beginning of Trace

If you select Yes, the tool will continue searching from the start of the Trace, then the following window will pop up:

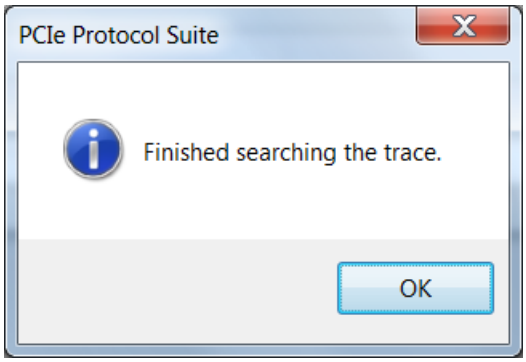


Figure 7.60: Finished Searching Trace

If the tool hasn't moved to a new Packet, the term being Searched for was not found.

7.11.2 Quick Search for MCTP Transactions

MCTP traces can use the Quick Search feature to look for MCTP Packets and Control Messages. See Figure 7.61.

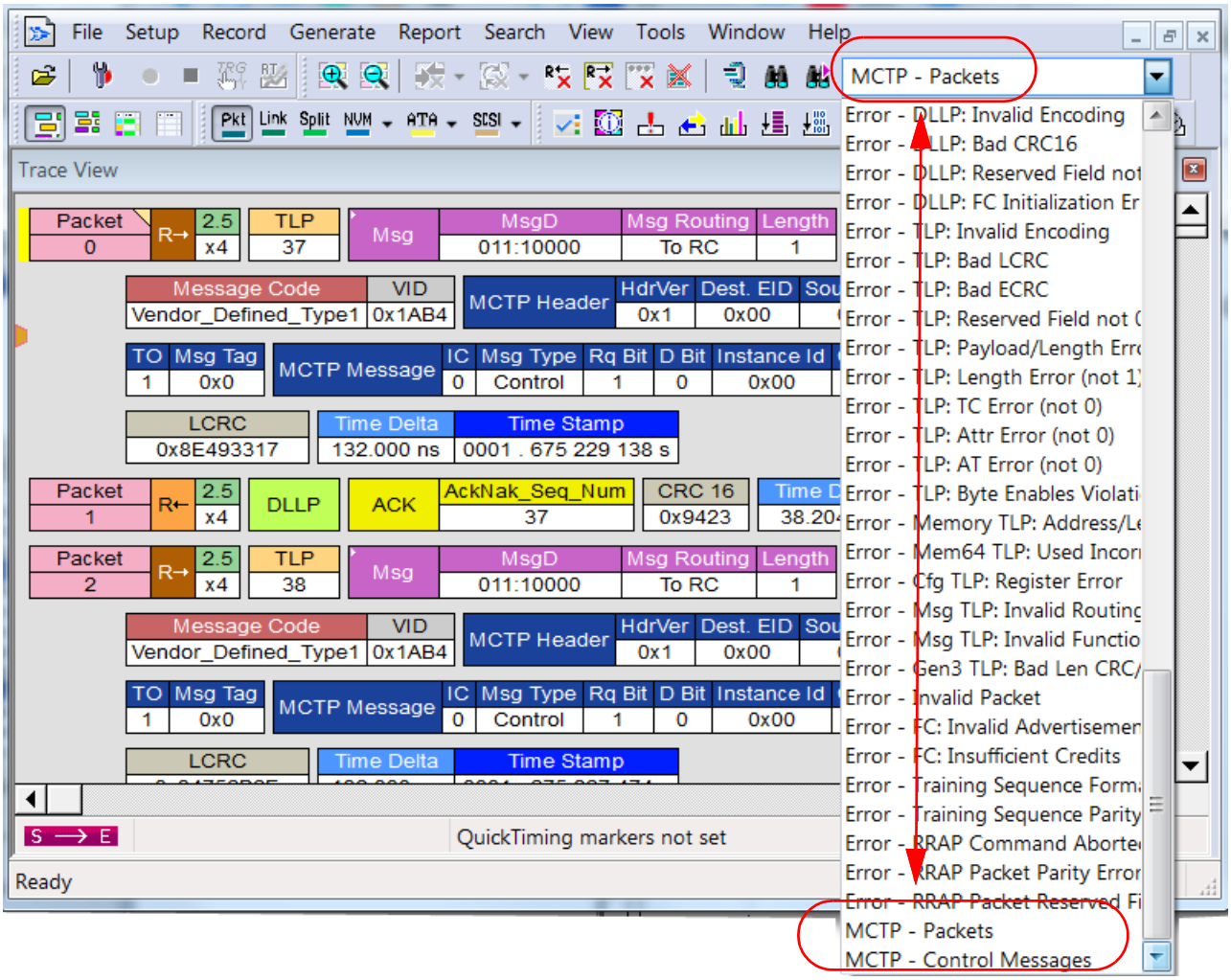


Figure 7.61: Quick Search Feature: MCTP Transactions

7.12 Toggle Search Direction

Search direction can be toggled back and forth by using the command under the Search menu. Search Direction controls the direction of the search. Each time Toggle Search Direction is selected, the search order is reversed. For example, if the previous search was **forward**, choosing **Toggle Search Direction** toggles the current search to **backward**.

To verify the direction of a search look at the lower right corner of the screen. **Search: Bwd** or **Search: Fwd** should appear. If a direction is not indicated, it means that the status bar is turned off.

To turn on the Status bar, select from the menu **View > Status Bar**.

Keyboard shortcuts can also be used to control search direction: Ctrl+b toggles the search direction.

Chapter 8

Display Options

8.1 Setting Display Options

Display Options allow you to customize the colors and formats of displayed traffic.

To open the Display Options dialog at the General tab, Select **Setup > Display Options** from the menu or click the **Display Options** button  on the toolbar. See Figure 8.1.

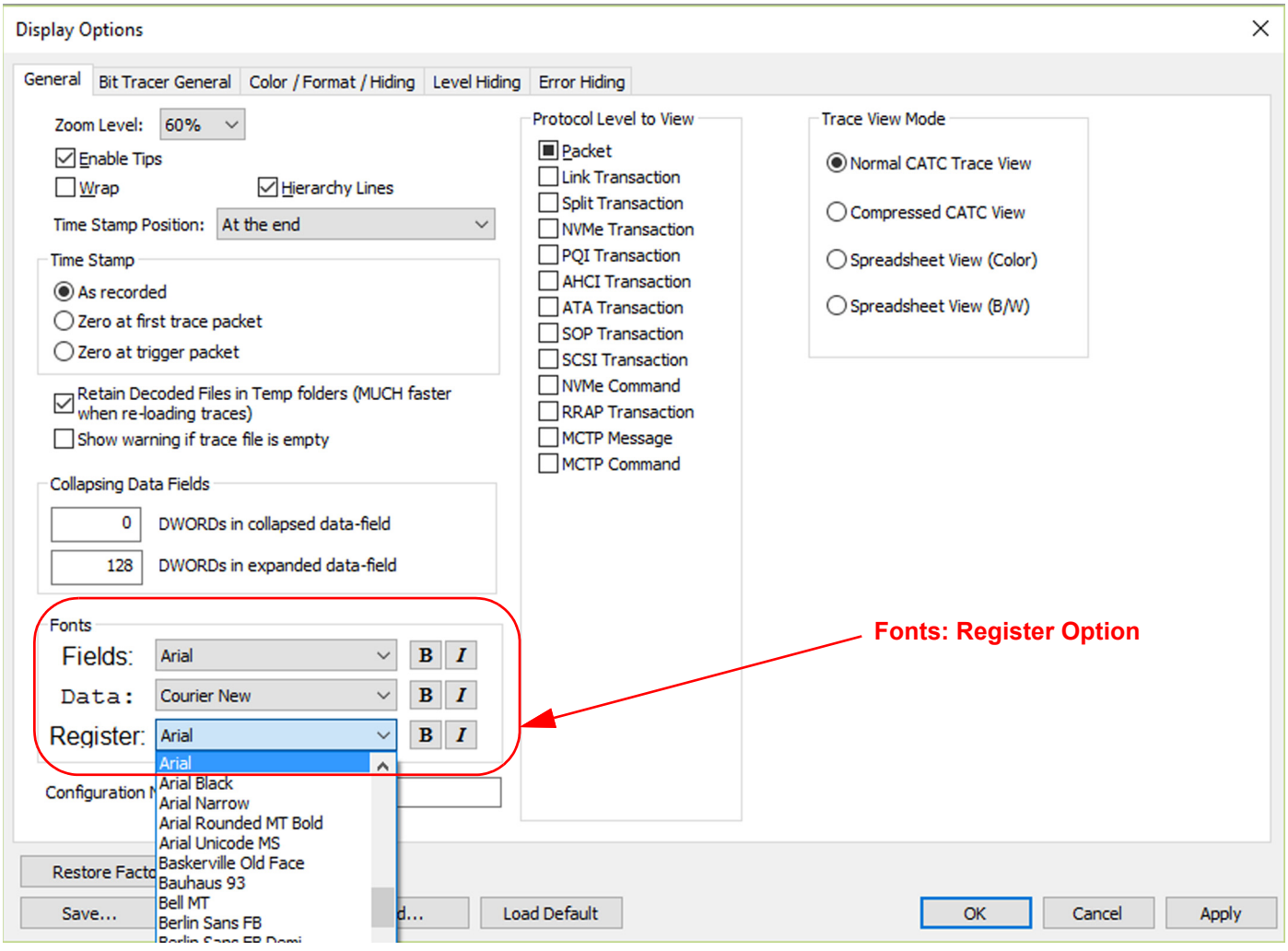


Figure 8.1: Display Options Dialog - General Tab with Register Option

8.2 Specifying General Display Options

The Display Options General tab allows you to specify:

Zoom Level: Defines the size of packet fields in the packet view. Zoom level is adjustable as 10, 20, 40, 60, 80, 100, 120, 140, 160, 180 and 200 percent.

Enable Tool tips: Allows information to be displayed on a packet by resting your mouse pointer over it.

Wrap: Allows packets, Link Transactions, and Split Transactions to wrap within the display.

Hierarchy Lines: Adds lines to the trace view indicating relations between packets, Link Transactions, and Split Transactions.

Timestamp position: Moves timestamp location from end of packet to beginning of packet, or merges it with the packet number.

Retain Decoded Files: Decoded Files are retained in Temp folders, which makes re-loading the trace much faster.

Empty Trace File Warning: If you've chosen recording conditions which result in an empty trace (no traffic is recorded), a warning message is displayed.

Protocol Level to View: Allows the CATC Trace to be displayed in different hierarchical levels: Packets, Link Transactions, Split Transactions NVMe, PQI, AHCI, ATA, SOP and SCSI command transactions.

Time Stamp: Gives you options for setting the timestamp to zero for either the first CATC Trace packet or the trigger packet or for leaving the stamp unchanged as it was originally recorded.

Trace View Mode: Displays Normal CATC Trace View, Compressed CATC View, Spreadsheet View (Color), and Spreadsheet View (B/W).

8.2.1 Collapsing Data Fields

This affects the "Data" field in the TLP packets when using the collapse feature (see Figure 8.2 on page 577).

0 in the collapsed field means no data will be shown. 128 in the expanded field means 128 DWords will be shown when the data field is expanded.

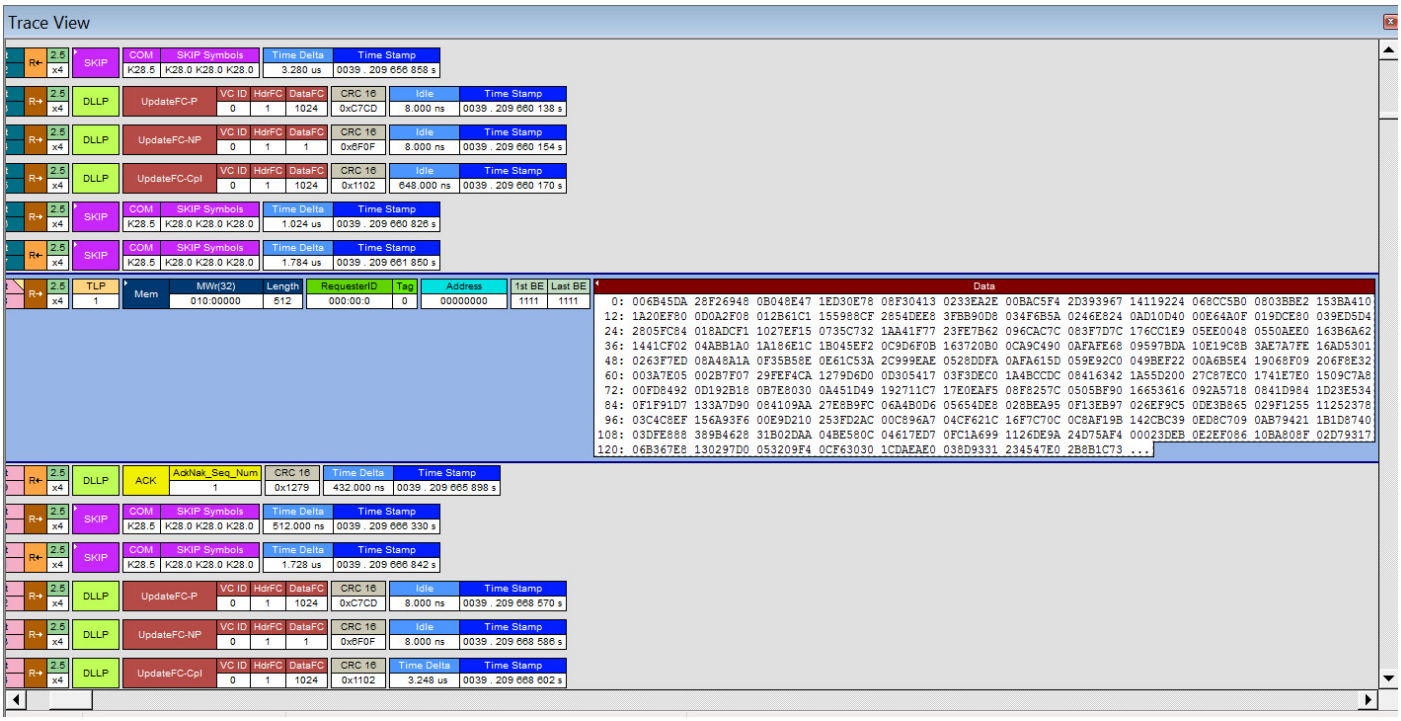


Figure 8.2: Expanded Data Field

8.2.2 Fonts

Fonts: Allows the appearance of field text and/or data text as well as Registers to be defined.

8.2.3 Configuration Name

Display Configuration Name: This field is used to enter a text string to be associated with the current set of Display Options. This name is saved with the Display Options file, and appears as part of the title of the packet view window that uses this set of Display Options.

8.2.4 Color, Format, and Hiding Options

The Color/Format/Hiding tab allows you to customize the colors and formats associated with each field in the CATC Trace and to selectively hide fields or packets. You access these display options by selecting **Setup > Display Options > Color/Format/Hiding** tab (see Figure 8.3 on page 578).

The Color/Format/Hiding property page lets you set how fields display in a CATC Trace. This property page lets you set field color and data format (binary, hex, decimal, ASCII), and lets you hide selected fields from the display.

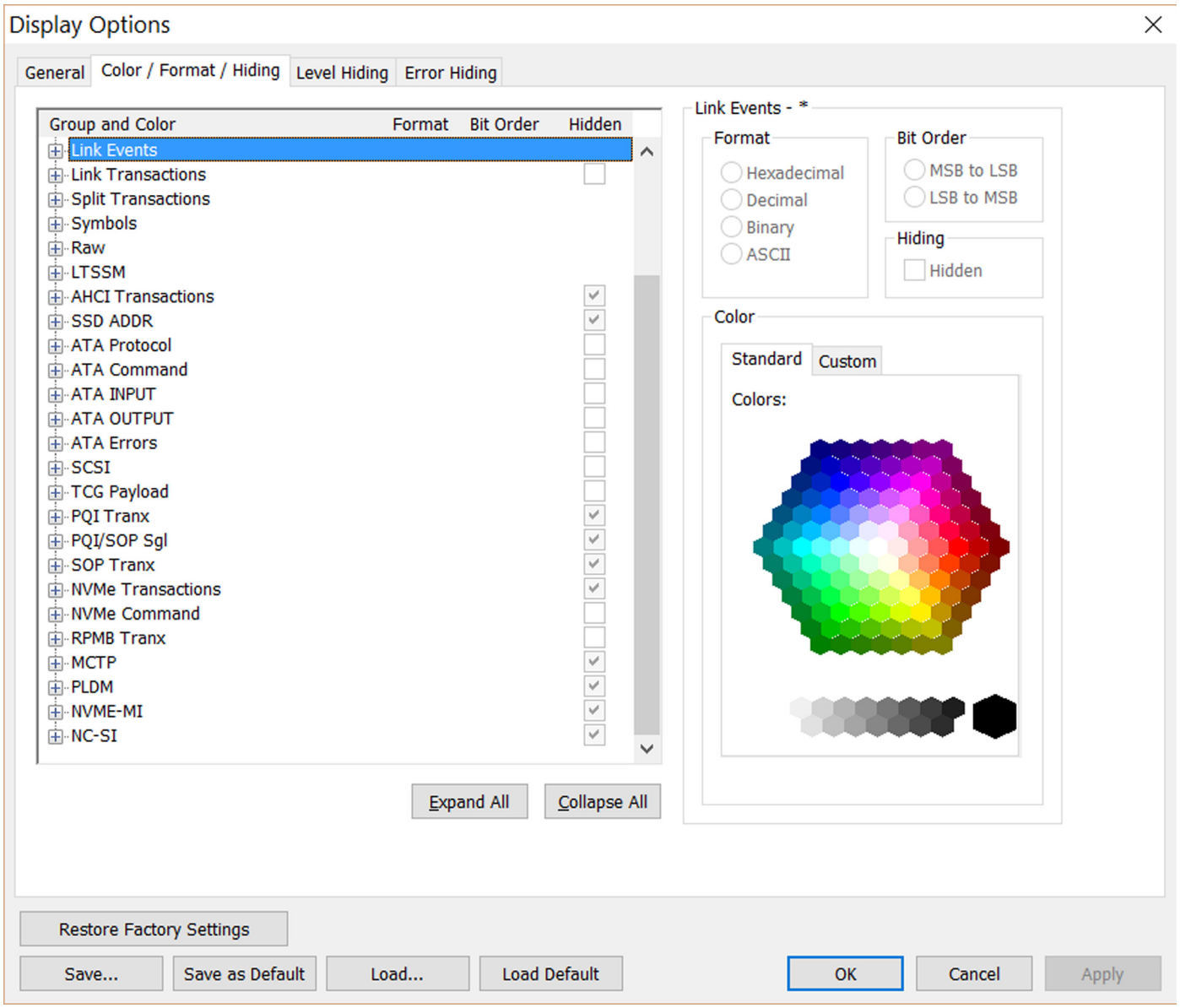


Figure 8.3: Display Options Dialog - Color/Format/Hiding Tab

8.2.5 Setting Field Colors

The Field Colors tab allows you to customize the colors associated with each field used in the packet view.

You may experiment with this option to achieve a color combination that suits you.

Select or change the trigger color using the color buttons labeled **- Packet #** and **+ Packet #** (before and after trigger) found under the Packet# section of the Field Colors window.

You select or change a color by clicking the appropriate color button. This action causes a color palette to pop up. Select the desired color and press OK.

1. Click **View > Set Display Options** to open the Display Options dialog.
2. Select the **Color/Format/Hiding** property page (see following figure).

3. Under the Group and Colors column, click the **plus** symbol (**+**) next to the group you want to reformat. The group expands to show the individual fields within the group. Each field has a color, as shown below:

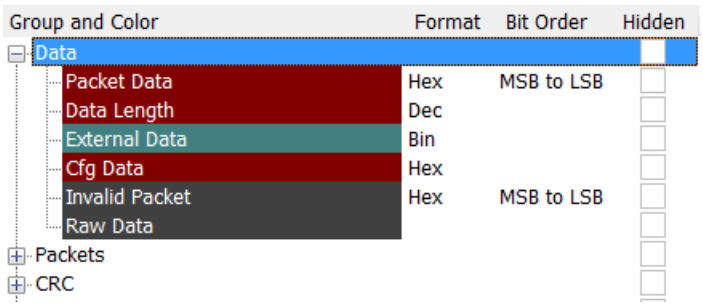


Figure 8.4: Group and Color for Data

4. Click the colored cell that you want to change. A color palette appears.
5. Click a color in the palette, then click **Apply** or **OK**.

Note: The colors of the following Frame types cannot be changed:

- Invalid Data (frame error) field (red)
- Softbit Errors (yellow)

You can also change color by right-clicking a field in the CATC Trace and selecting Color from the pop-up menu (see Figure 8.5 on page 580).

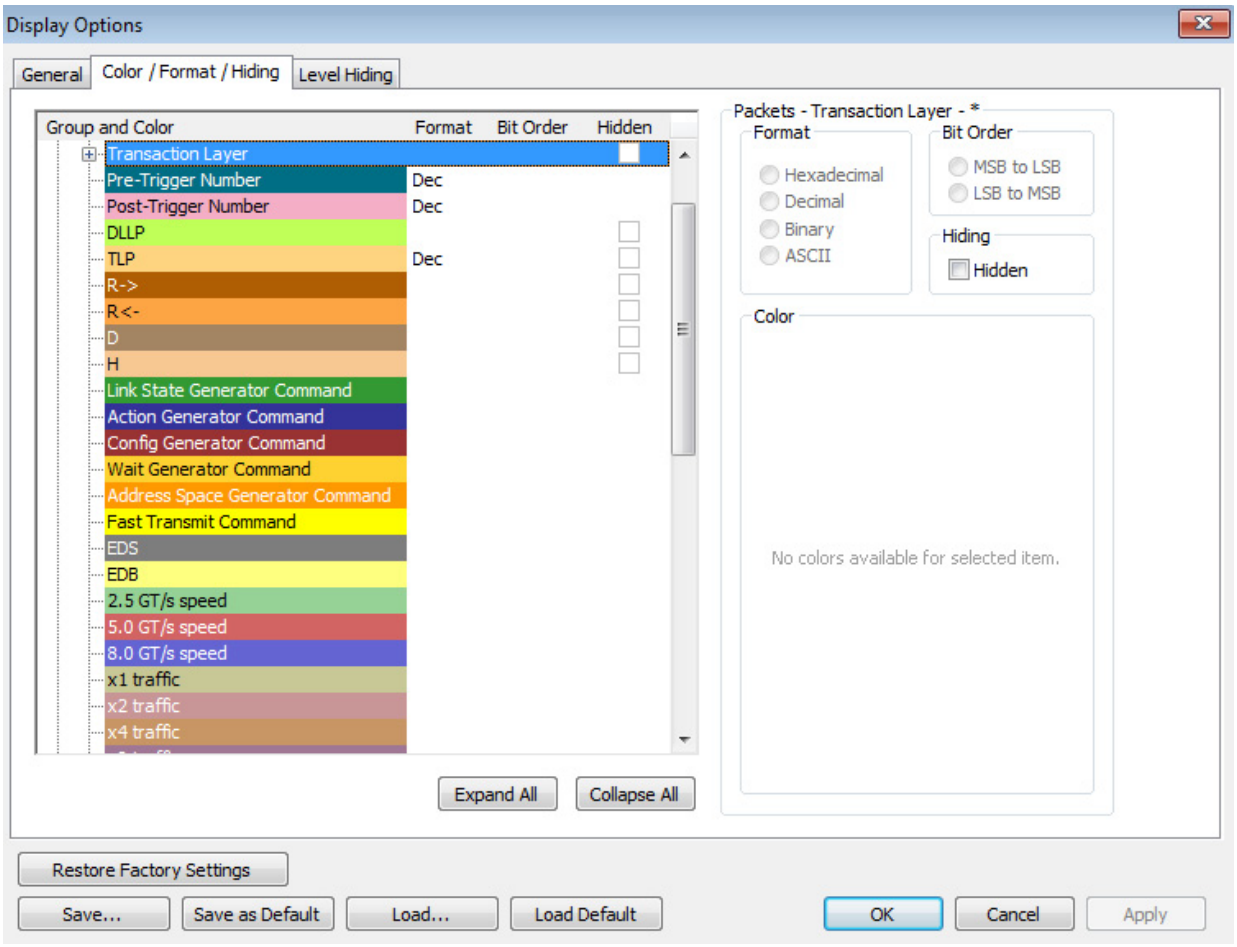


Figure 8.5: Display Options Dialog Color/Format/Hiding Tab

8.2.6 Changing Field Formats

The Field Formats tab allows you to define the way various numeric fields are shown in the packet display. You can select Hexadecimal, Decimal, Binary, or ASCII for certain fields or groups of fields.

To change a field's format, click the plus sign (+) next to a field in the list. This causes the selected item to expand so you can see its constituent sub-fields. Select a sub-field, and then choose the format from the formatting choices that appear at the bottom right of the window (see Figure 8.6 on page 581).

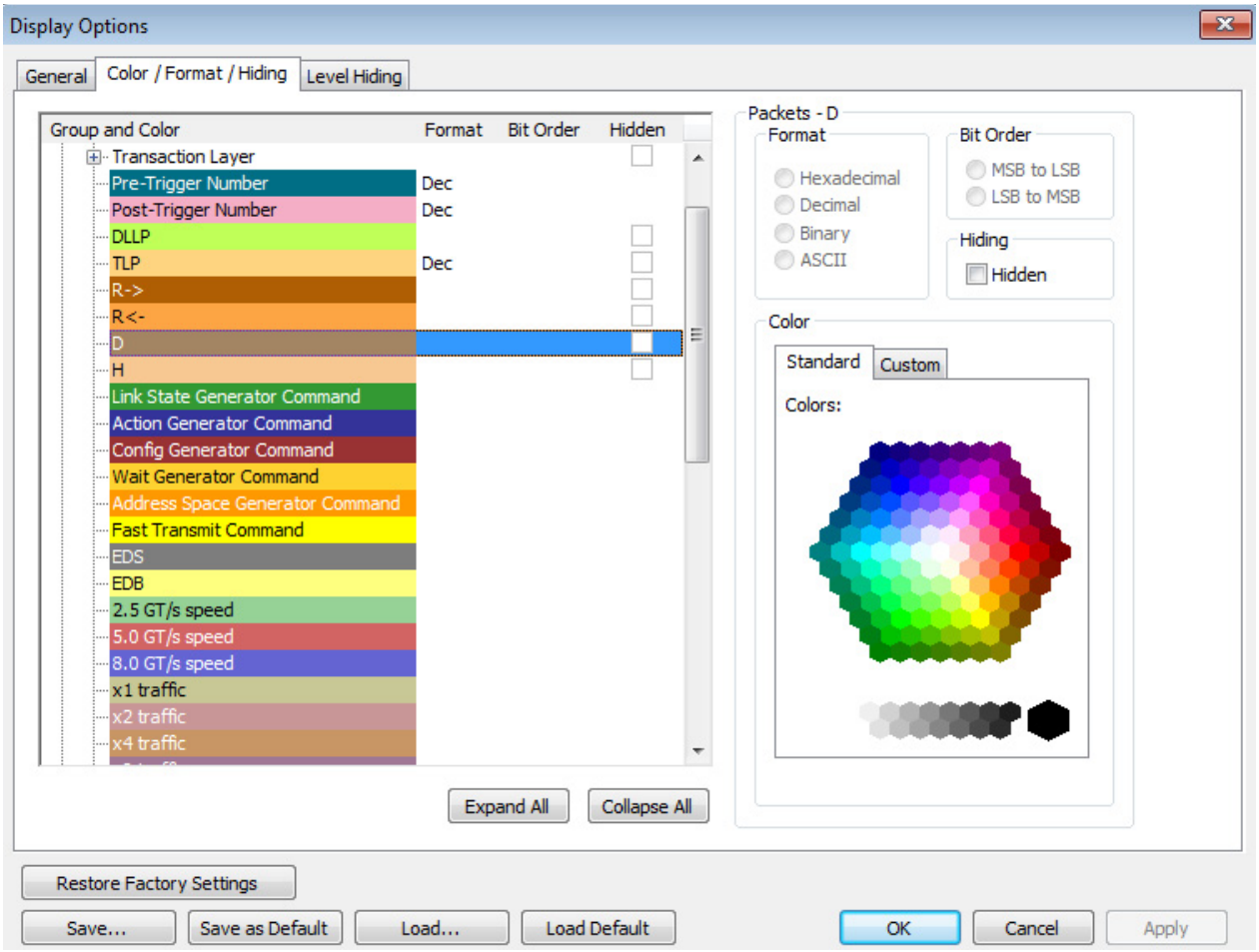


Figure 8.6: Display Options Dialog Color/Format/Hiding Tab

To change the format of alphanumeric characters in a field:

1. Under the Group and Colors column, click the **plus** symbol (**+**) next to the group you want to reformat. The group expands to show the individual fields within the group (as shown above).
2. Click the **row** representing the field that you want to reformat. If the field can be reformatted, the format options become active, and choose an option from the list as shown below:

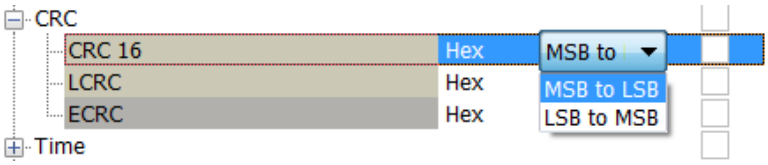


Figure 8.7: Change Format of Character

3. Select a **format**.
4. Specify the bit order in the displayed fields by checking/unchecking the **MSB > LSB** checkboxes.
5. Click **Apply** or **OK**.

8.2.7 Hiding Fields

To hide a field:

1. Under the Group and Colors column, click the **plus** symbol (**+**) next to the group that has the field(s) you want to hide. The group expands to show the individual fields within the group (as shown above).
2. Click the **checkbox** in the row representing the field that you want to hide.
3. Click **Apply** or **OK**.

8.2.8 Level Hiding

The Level Hiding tab lets you hide traffic by Event Group (see Figure 8.8 on page 582). If you select one or more event types from the Event Group list, the selected types are hidden from the CATC Trace.

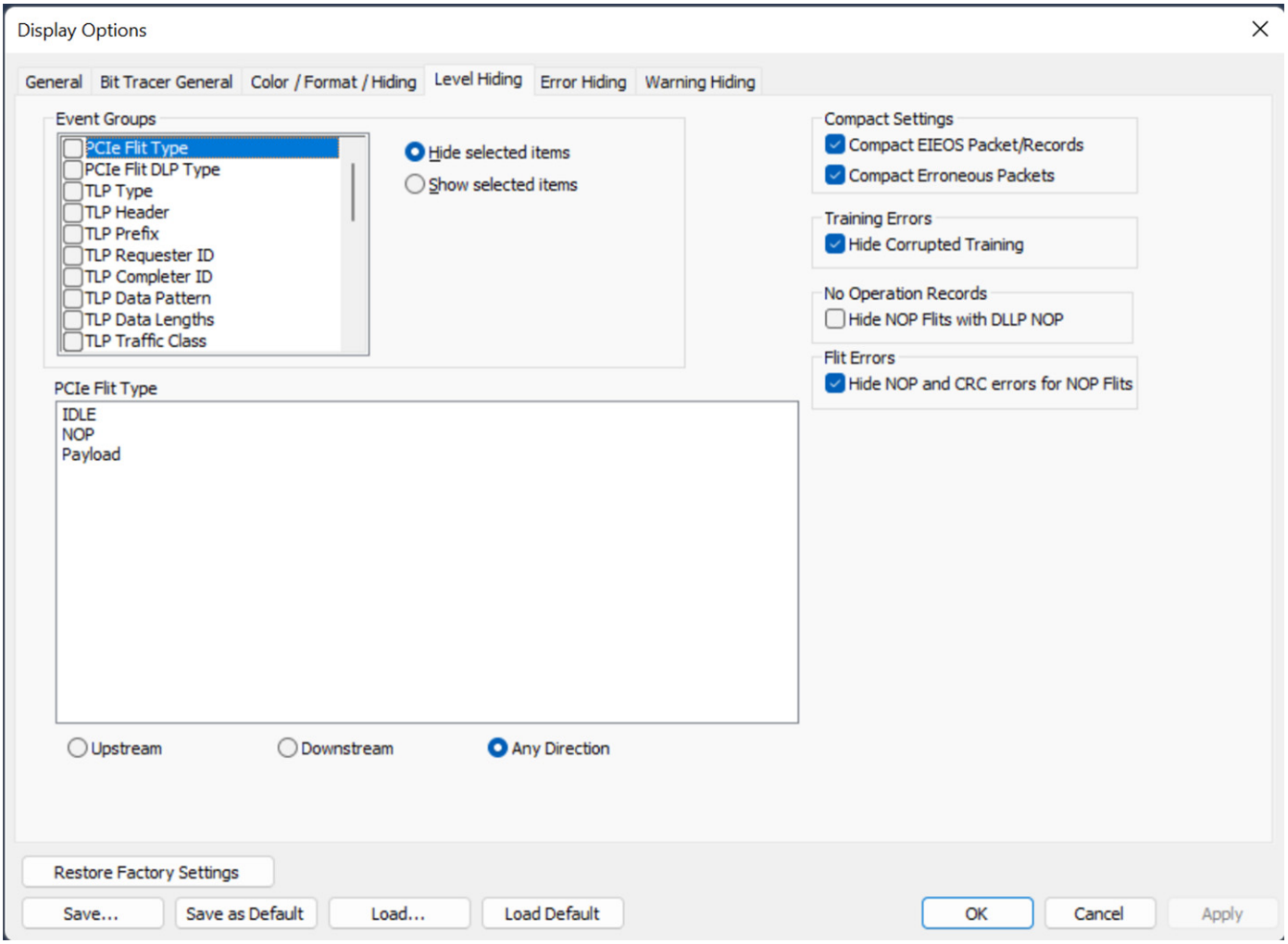


Figure 8.8: Display Options Dialog - Level Hiding Tab

To hide a level:

1. Select an Event Group.

2. Select whether to **Hide** or **Show selected items**.
3. Select **Upstream, Downstream**, or **Any Direction**.
4. (Optional) Select **Sideband** signals. (These include SMBus signals).
5. (Optional) Select **Compact EIEOS packets** and/or **Compact Erroneous Packets**.
6. (Optional) Select **Hide Corrupted Training**.
7. (Optional) Select **Hide NOP Flits with DLLP NOP.**
8. (Optional) Select **Hide NOP and CRC Errors for NOP Flits.**
9. Click **OK**.

The Event Groups for Packets are:

- TLP Type
- TLP Header
- TLP Requester ID
- TLP Completer ID
- TLP Data Pattern
- TLP Data Lengths
- TLP Traffic Class
- TLP Tag
- TLP Sequence Number
- DLLP Type
- DLLP Header
- DLLP Virtual Channel
- ACK/NAK Seq Number
- Ordered Sets
- Link Event
- OBFF Code
- Direction
- Errors
- TS1 Data
- TS2 Data

The Event Groups for Link Transactions are:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- RequesterID
- CompleterID
- Status
- Tag

The Event Groups for Split Transactions are:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- RequesterID

- CompleterID
- Status
- Tag
- Address

The Event Groups for NVMe transactions are:

- Controller Registers
- Other NVMe Entities
- Queue IDs
- Command IDs
- Doorbell Registers
- Admin Submission Command Set
- NVMe Submission Command Set
- Completion Queue Entry
- PRP
- Submission Command
- NVMe Errors

The Event Groups for PQI Transactions are:

- PQI Register ID
- PQI Admin Functions
- PQI Errors

The Event Groups for AHCI Transactions are:

- AHCI Register ID
- AHCI Port Number
- AHCI Slot Number
- AHCI Port Multiplier Port
- AHCI Raw Address
- AHCI Direction
- AHCI Errors

The Event Groups for ATA transactions are:

- ATA Register Type
- ATA Port Number
- ATA Slot Number
- ATA Raw Address
- ATA Port Multiplier Port
- ATA Interruption Reason
- ATA Error Type
- ATA Input/Output
- ATA Payload Portion
- ATA CFIS Fields
- ATA RFIS Device to Host Fields
- ATA DSFIS Fields
- ATA PSFIS Fields
- ATA SDBFIS Fields

The Event Groups for SOP transactions are:

- SOP Information Unit ID
- SOP Errors

The Event Groups for SCSI transactions are:

- SCSI Operation
- Command Status
- Task Management
- Task Management Response
- Errors
- SCSI Logical Unit Numbers

The Event Groups for NVMe Commands are:

- Admin Command Set
- NVME Command Set
- Submission QID
- Completion QID
- Status
- Errors
- TCG Types
- TCG Method
- TCG Invoker
- TCG Com ID
- TCG Ext Com ID

8.2.9 Error Hiding

The Error Hiding page lets you hide errors by Transaction Types (see Figure 8.9). If you select one or more transaction types from the list, the selected types are hidden from the CATC Trace.

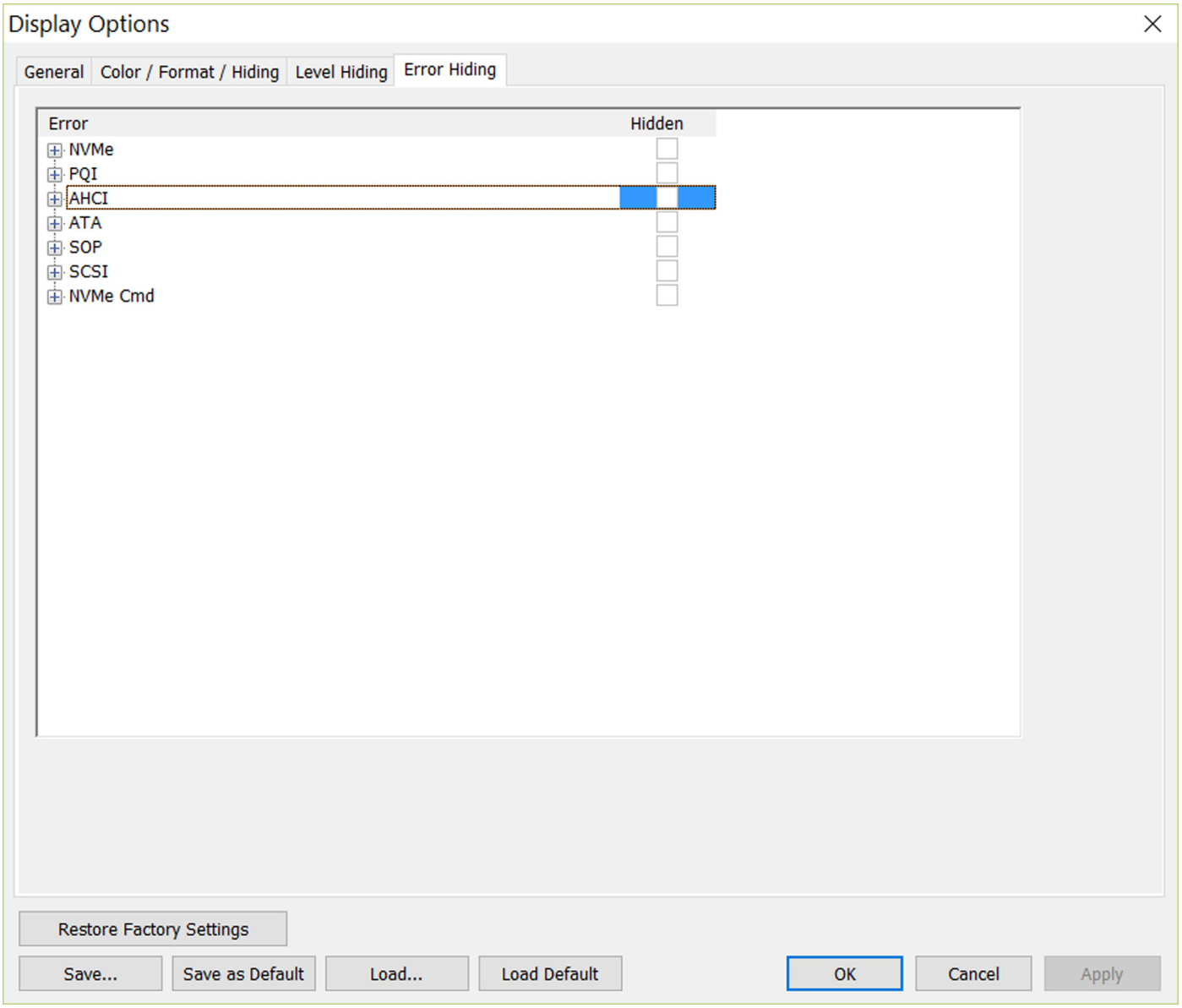


Figure 8.9: Display Options: Error Hiding

8.2.9.1 Transaction Types

The Transaction Types which can have their errors hidden include:

- NVMe
- PQI
- AHCI
- ATA
- SOP
- SCSI

- NVMe Cmds

Each Transaction Type has a large selection of errors that can be selectively hidden. See Figure 8.10, Figure 8.11 on page 588 and Figure 8.12 on page 589.

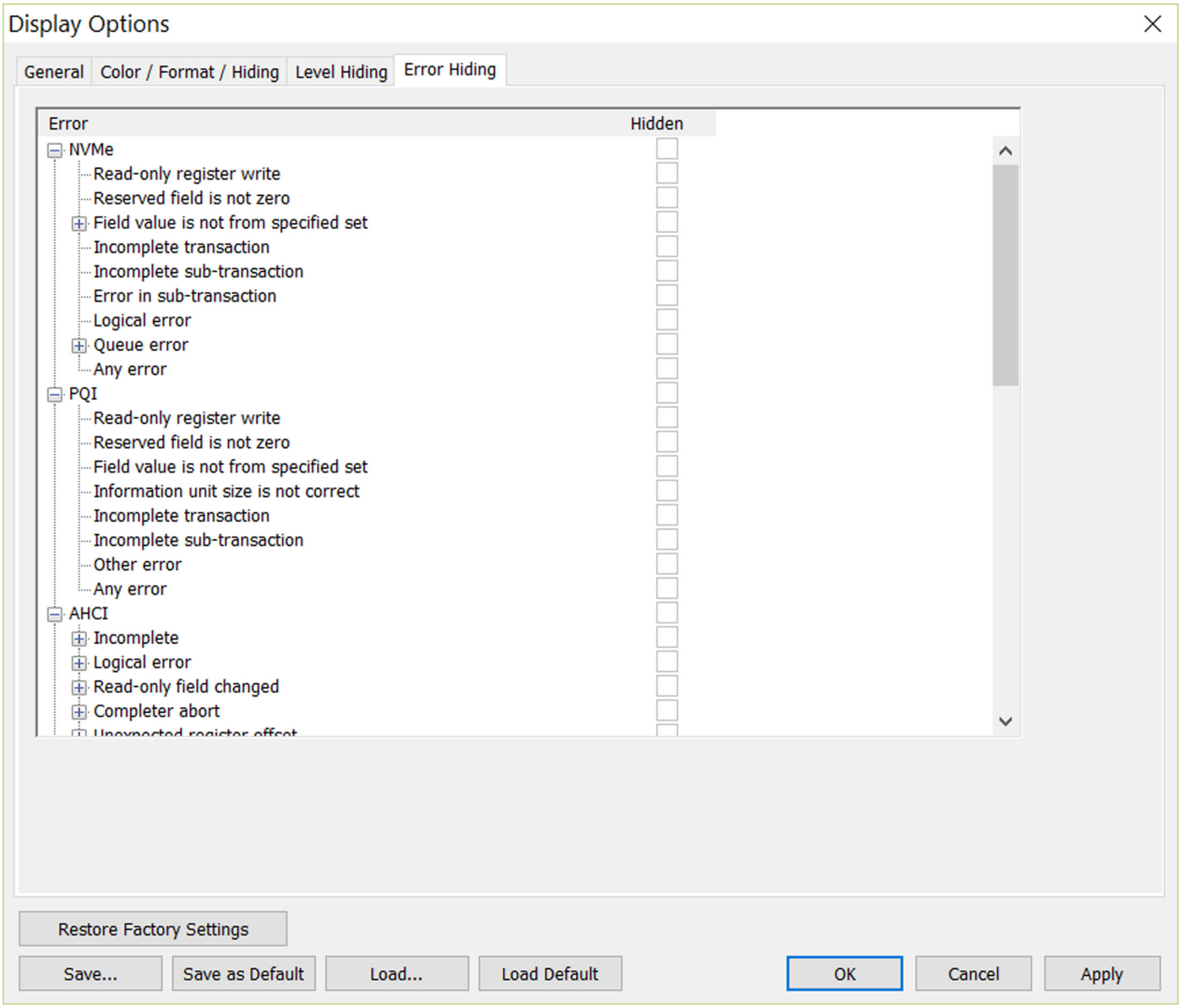


Figure 8.10: Display Options: Error Hiding -> Transaction Types: NVMe/PQI/AHCI

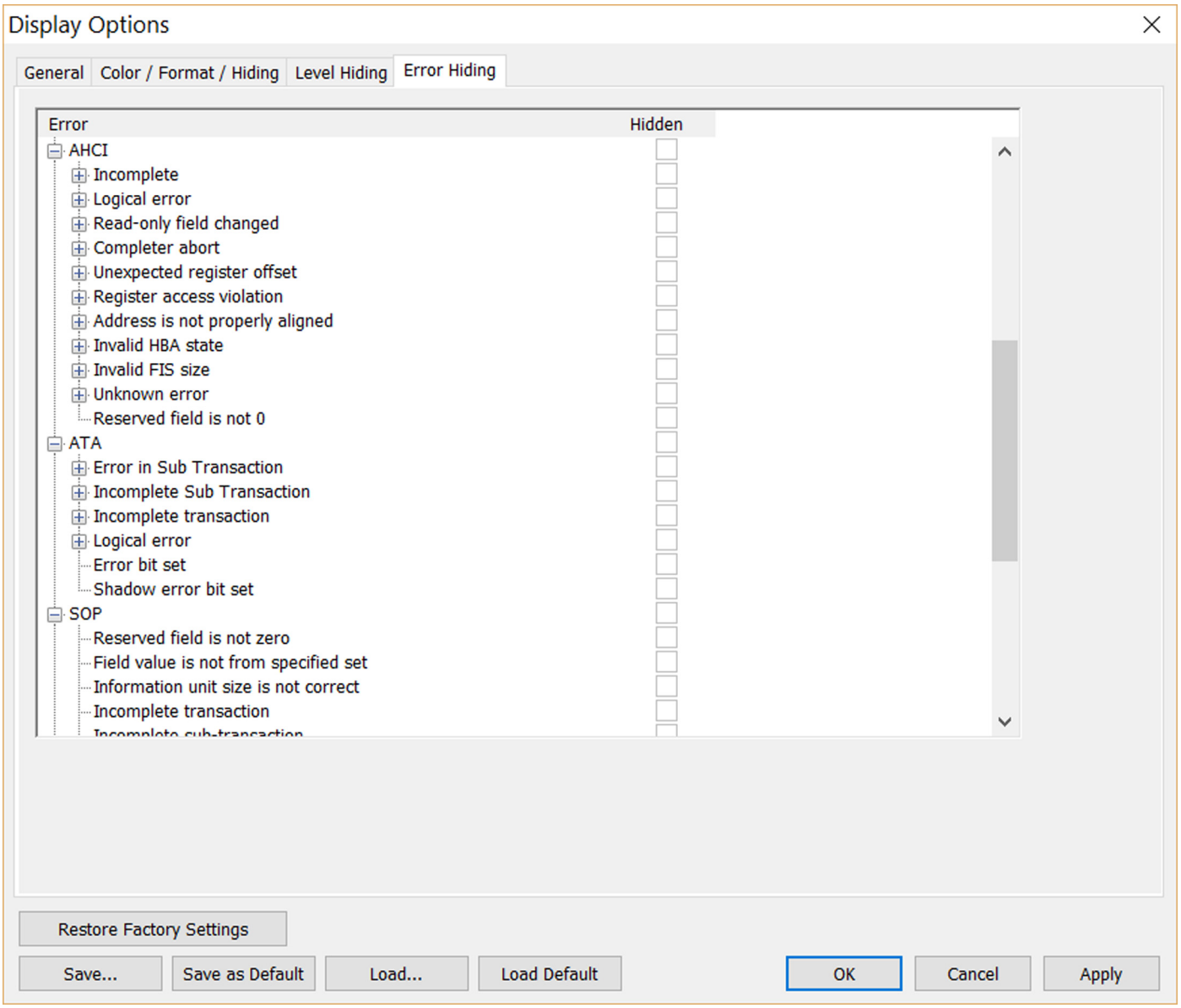


Figure 8.11: Display Options: Error Hiding -> Transaction Types: AHCI/ATA/SOP

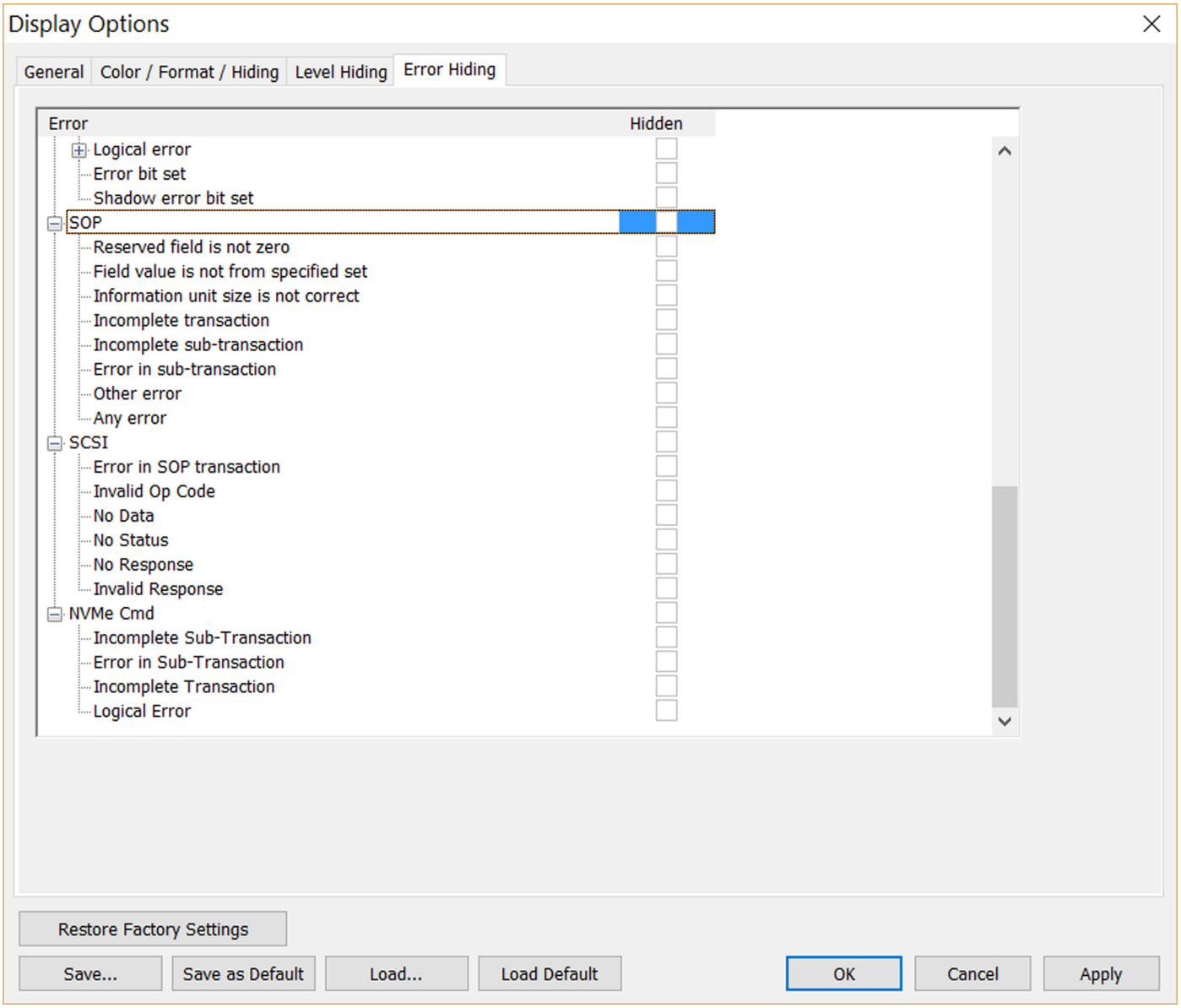


Figure 8.12: Display Options: Error Hiding -> Transaction Types: SOP/SCSI/NVMe Cmd

8.2.10Warning Hiding

The Warning Hiding page lets you hide warnings by Transaction Types (see Figure 8.13). If you select one or more transaction types from the list, the selected warnings are hidden from the CATC Trace.

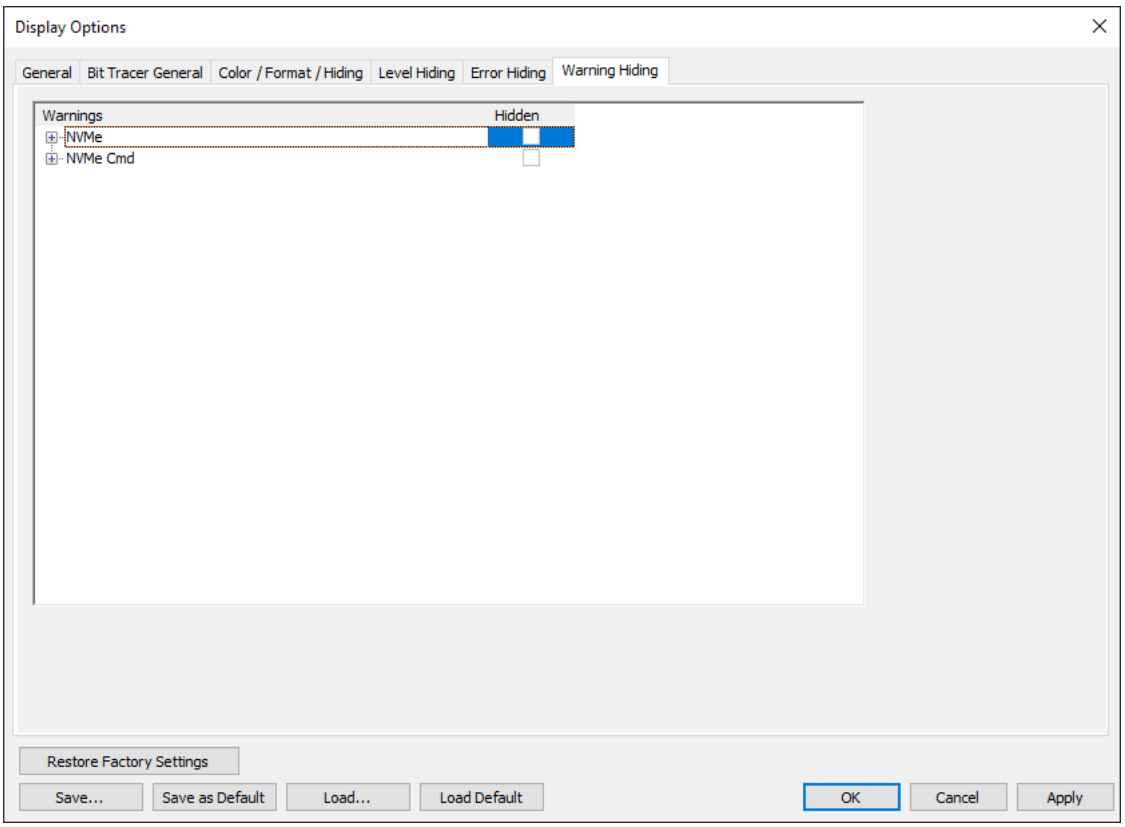


Figure 8.13: Display Options: Warning Hiding

8.2.10.1 Transaction Types

The Transaction Types which can have their warnings hidden include:

- NVMe
- NVMe Cmds

8.3 Load a Previously Saved Display Options File

If you have previously saved Display Options, you can load them by opening the Display Options dialog and clicking the **Load** button. A dialog opens to let you load a previously saved display options file.

1. Click **Load** to use a previously defined display options file.
2. When you see the Open File pop-up window, enter the name of the file you want to load and click **Open**.
3. When the PCIe Protocol Analysis™ returns you to the Recording Options menu, click **OK** to activate the display options you selected.

8.4 Saving Display Options

If you have customized the Display Options and wish to save them, you can do so by clicking the **Save** button, then entering a unique file name. The **.opt** extension is added by default.

Setting the Defaults: Save the currently specified Display Options to the file name: **default.opt** by clicking **Save As Default.** When the Analyzer software begins execution, it automatically loads the **default.opt** file, if one exists.

Chapter 9

BitTracer Recording

Note: BitTracer Recording is an optional feature.

The Summit Analyzer Series (T3-16, T3-8, T34, T28 and T24) has an optional **BitTracer** data capture mode, which captures bi-directional link traffic in raw format. The BitTracer recording mode captures and displays traffic before lane-to-lane de-skew operations and before descrambling of 10b bytes. The BitTracer mode includes support for multiple logical links (bifurcations) on a single physical link.

The BitTracer recording mode has its own user interface, which provides characterizations of link traffic that are not available in the standard protocol analyzer mode. You can export BitTracer recordings for viewing in CATC Trace format.

Note: This feature can be included at initial purchase or added in the field with a software upgrade license. To obtain a software license key to add this feature, contact Teledyne LeCroy.

Lane Deskew Bypass in recording options prevents lanes from being bonded by the analyzer, allowing you to troubleshoot problems with physical layer.

9.1 Enabling BitTracer Recording

To enable the BitTracer recording mode, open the **Recording Options**.

In the Target Analyzer section of the General tab, select **Summit T3-16** or any other Summit Analyzer you are working with**.**

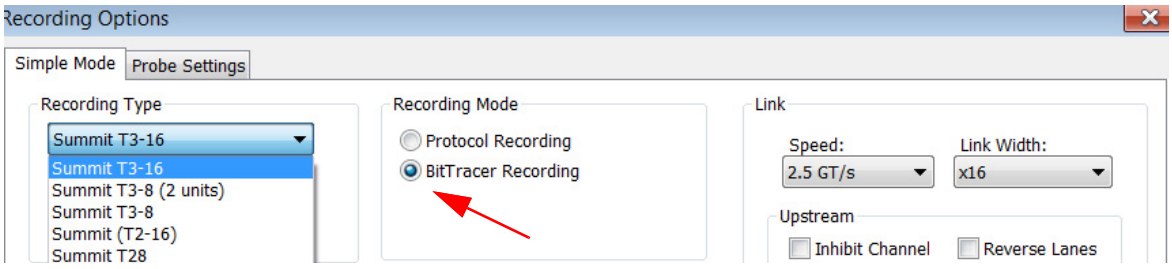


Figure 9.1: Recording Mode

In the Recording Mode section, select **Bit Tracer Recording.**

.

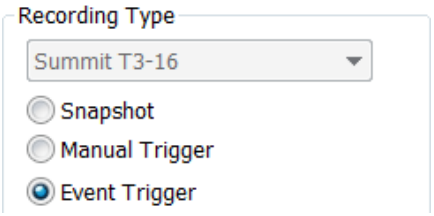


Figure 9.2: Recording Type

In Bit Tracer Recording, you can use the Snapshot, Manual Trigger, and Event Trigger recording types.

Note: You can also use other standard Recording Options, such as Link Width, Buffer Size, and Lane Polarity Settings, to characterize the link.

9.2 Trigger Modes

If you select Event Trigger, you may select basic trigger settings in the Trigger On dialog.

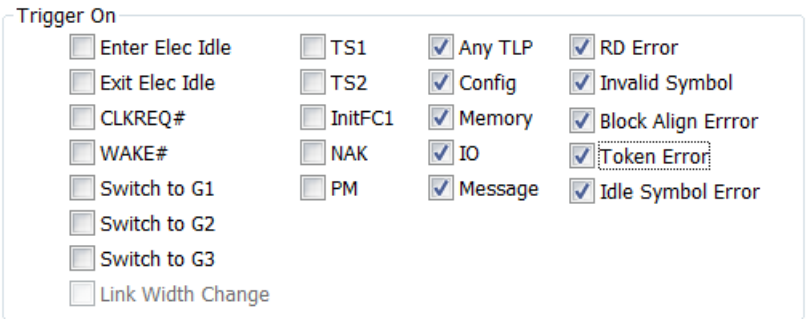


Figure 9.3: Trigger On Dialog

9.3 Views Available for Captured Data

BitTracer mode displays captured data lane-by-lane and byte-by-byte in each direction (upstream and downstream), with the time scale progressing left to right.

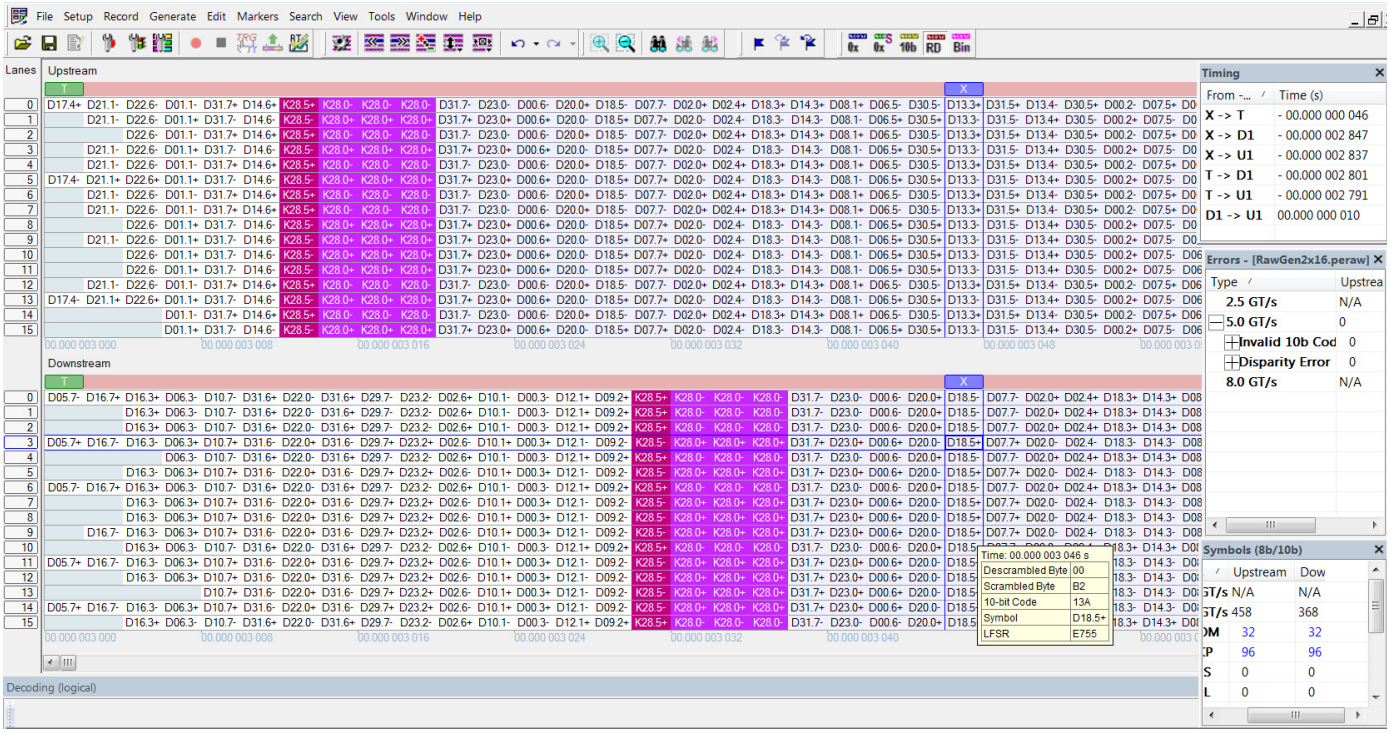


Figure 9.4: Captured Data

Other views are provided for timing measurements, marker placement, physical layer errors, captured symbol types, packets, events, and decoding of ordered sets and packets. You can view any or all displays simultaneously, using the **Windows** selection in the View menu.

9.4 De-skewing Data

By default, BitTracer recordings display captured data in time de-skewed format, across all lanes for both directions. But it is possible, for debug purposes, to bypass this de-skew using the **Lane De-skew Bypass** check box in **Recording Options**.

When lanes are not de-skewed, individual bytes are as they were captured on the recorded link, before the receiver device on the link (or the receiver logic on the PCIe Protocol Analysis analyzer) has performed lane-to-lane de-skew operations. You can manually skew the captured data, left or right, in increments of one symbol time (for Gen2 this is one byte) using the associated toolbar buttons. See Figure 9.5 on page 596.

Note: For Gen3 you can manually skew the captured data, left or right, in increments of 1 bit using the associated toolbar buttons.

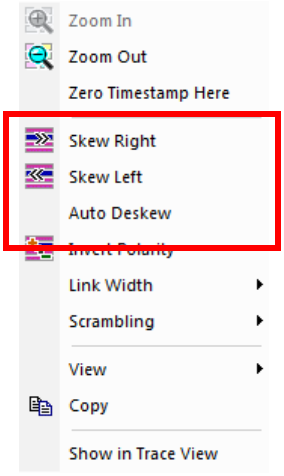


Figure 9.5: Skewing Data

You can automatically de-skew an entire lane direction. First, left-click on the direction in the data window. Then right-click to display a popup menu. Then select **Auto De-Skew.**

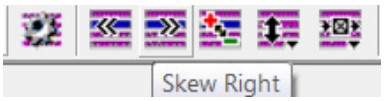


Figure 9.6: De-Skew Data

You can de-skew only one direction for each right-click operation. To automatically de-skew the opposite direction, first left-click on that direction in the data window.

Note: The skew observed in the bit tracer is the actual skew of the lanes in the link plus the skew introduced by the analyzer interface. The De-skew Bypass option is not intended for skew measurements or estimations.

9.5 Data Display Formats

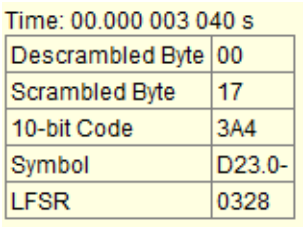
To display traffic in K/D symbol (with Running Disparity indicated), scrambled, descrambled, 10-bit, and Binary code formats:

- Use the toolbar.



Figure 9.7: Data Formats

- Right-click to display a menu.
- Place the cursor over any given byte to display all byte formats (including an LFSR value) in pop-up list.



Time: 00.000 003 040 s

Descrambled Byte	00
Scrambled Byte	17
10-bit Code	3A4
Symbol	D23.0-
LFSR	0328

Figure 9.8: Pop-up List

Note: Descrambled values can only be displayed after the first recorded skip ordered set. Data prior to the skip is displayed in scrambled values, due to the unknown LFSR.

Note: For Binary Data Display Format, bits are shown in order of transmission on the bus.

9.6 Color-Coding of BitTracer Contents

To increase visual understanding of BitTracer displays, different symbol types have color-coding:

- Presence or non-presence of a lane's byte-lock
- Idle data characters (D0.0)
- K codes
- Invalid 10b symbols
- Signal presence
- Background of the Markers Bar (see "Markers/Speed Bar" on page 599). (color coded according to traffic speed).
- All symbols of a TS1/TS2 ordered set

By default, these color selections match the standard color selections used in the CATC Trace format. You can modify them in the Display Options menu, accessible from the Main toolbar or the Setup menu.

9.7 Report and Analysis Windows

In the report windows, BitTracer mode provides several functions to analyze traffic:

- Statistical information
- Timing measurements
- Packet decoding

To activate/deactivate a report window, use **Views > Windows,** see Figure 9.9 on page 598.

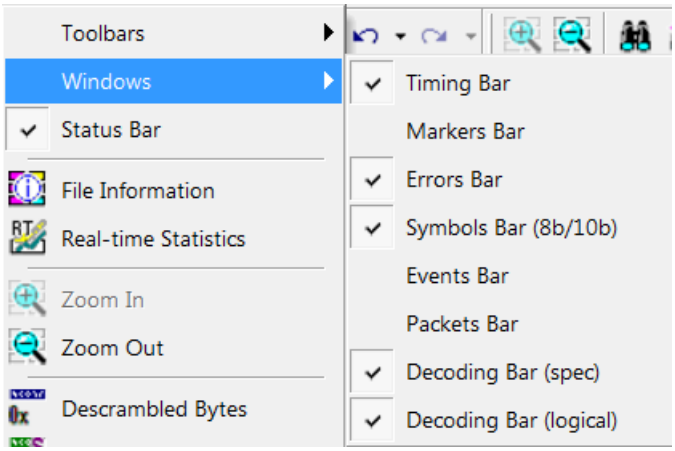


Figure 9.9: Activate/Deactivate Reports

You can rearrange the report windows.

All report windows are dockable.

9.8 Timing Measurements Bar

BitTracer mode provides timing measurements on captured data:

- Measurements from the Trigger position relative to user-selected X and Y markers
- X-Y measurements
- Measurements between user-defined markers

9.8.1 Markers/Speed Bar

Markers are displayed in the speed bar above the data. Place your cursor in the speed bar and the Current speed will be displayed. In this case, the traffic was running at 5.0 GT/s when the trace was taken. See Figure 9.10.

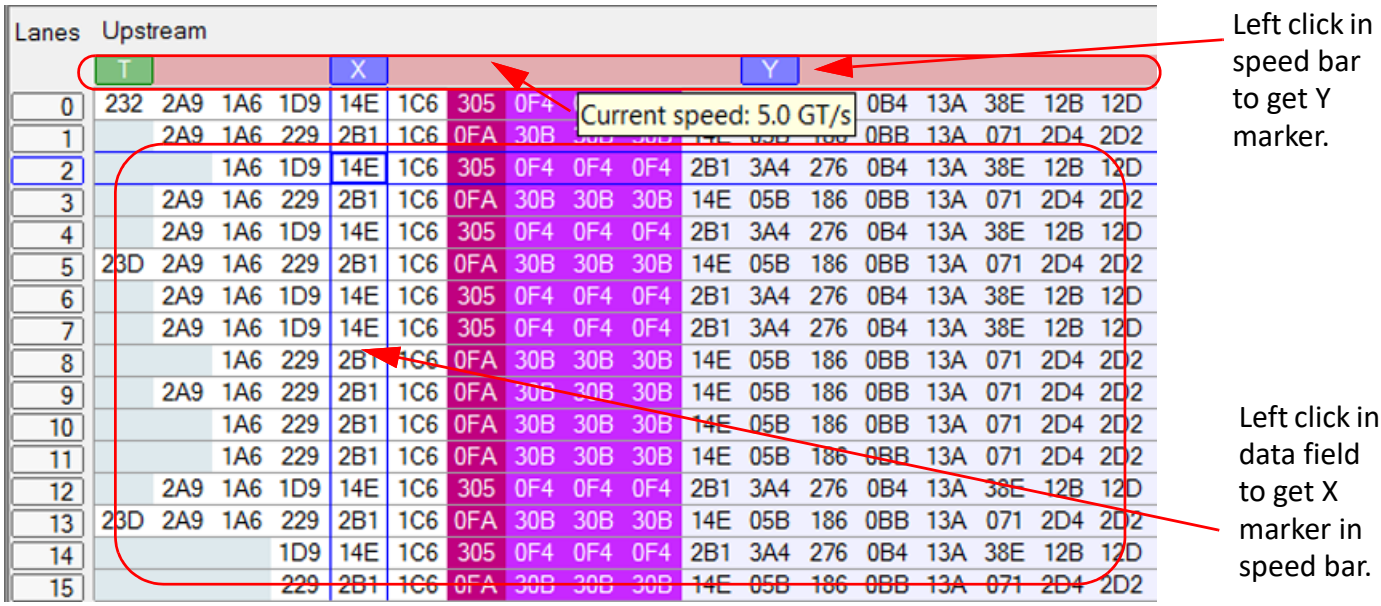


Figure 9.10: Marker/Speed Bar Example

The Trigger marker T is at the point where BitTracer recognized the user-defined trigger condition.

To set an X marker X, left-click anywhere in the data display, see Figure 9.10.

To set a Y marker Y, left-click in the narrow speed bar where the T and X markers are displayed. See Figure 9.10.

9.8.2 Defining a Marker

To define a marker, select the **Set Marker** command in the Markers menu or use the **Toggle Marker** icons in the toolbar. You can also use the Jump to Next or Previous marker icons in the toolbar.



Figure 9.11: Define a Marker

User-defined markers are numbered in the order they were placed:

- U1 U1, U2, and so on in the upstream direction
- D1, D2 D2, and so on in downstream direction.

You can set a marker with text using the **Set Marker with Text...** command in the Markers menu. After setting the marker, when the mouse pointer is on the marker symbol, the marker text displays as a tooltip.

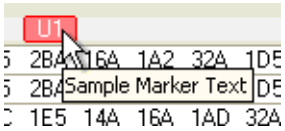


Figure 9.12: Set a Marker

You can also display the Markers window, which lists all markers and their locations, including a hyperlink for each.

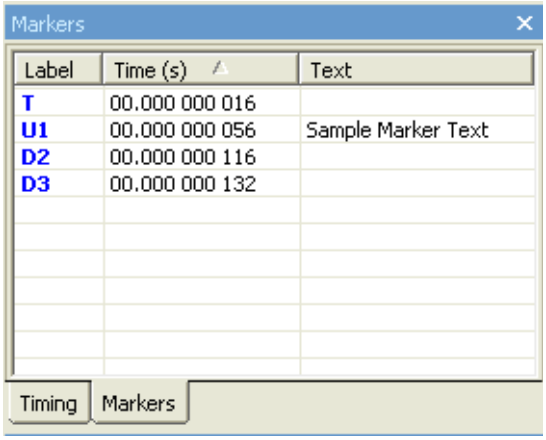


Figure 9.13: Display Markers Window

Timing measurements between all combinations of X, Y, U, and Trigger cursors are in the Timing window.

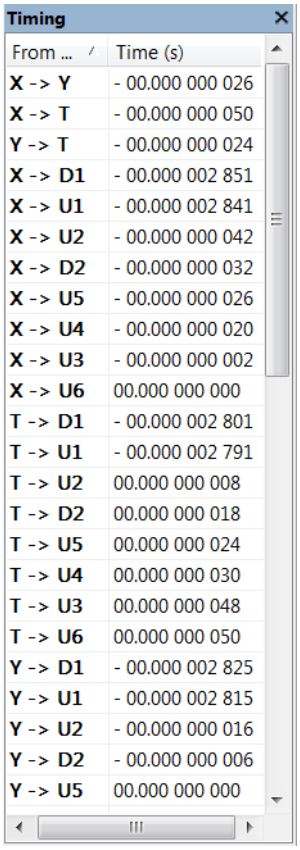


Figure 9.14: Timing Window

9.9 Errors Bar

BitTracer mode provides a summary of 10b errors (invalid symbols) and disparity errors in the Errors window. The window shows the total error count and errors per-lane for each error type. Hyperlinks allow jumps to selected errors.

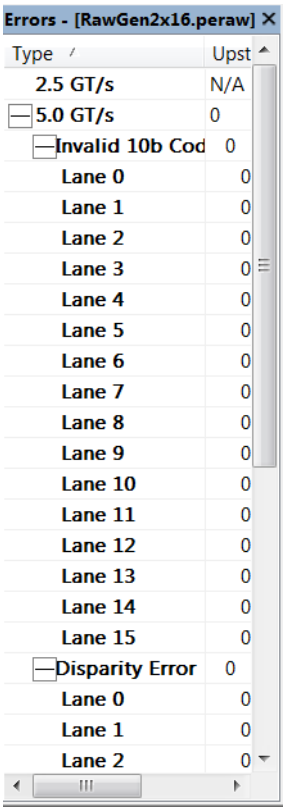


Figure 9.15: Errors Window

BitTracer mode also highlights errors:

- Invalid symbols have a black background.
- Bytes with incorrect running disparity have red borders.

9.10 Symbols Bar

The Symbols window provides a summary of the different symbol types captured, by quantity and direction, and includes hyperlinks for jumps to selected symbols.
Expanding the + sign at the left of each symbol provides a summary of symbols by lane.

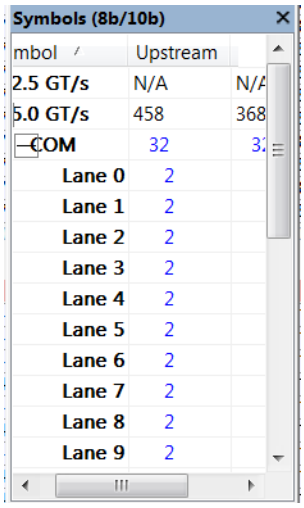


Figure 9.16: Symbols Window

9.11 Events Bar

The Events report window summarizes Link Up, Link Down, and Speed Switch events for Upstream and Downstream.

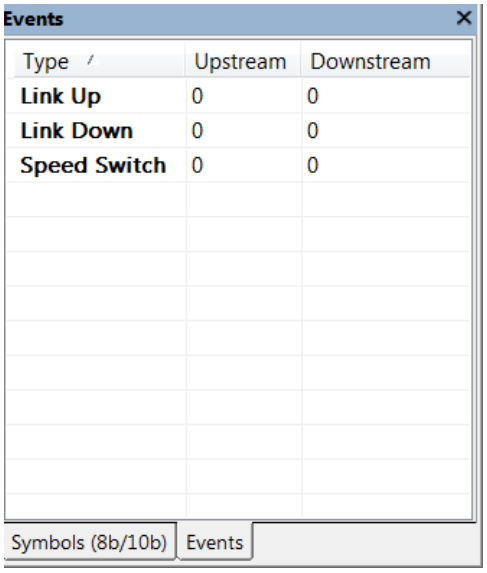


Figure 9.17: Events Window

Note: The table entries are hyperlinks.

9.12 Packets Bar

The Packets report window summarizes packet types detected in the file.

Note: To obtain packet types, you must perform a post-capture "Analyze" step. After capture, when you open the Packets Bar for the first time, items can display the command "Analyze". To start the analysis, click the word **Analyze**. After analysis finishes, the results are saved with the file. Therefore, you do not need to click **Analyze** the next time.
The table entries are hyperlinks.

Note: If you edit anything, the results are no longer valid, and the system requires you to click **Analyze** again.

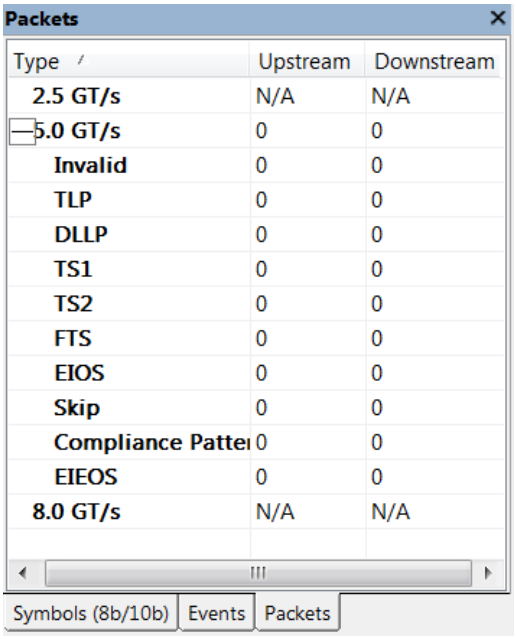


Figure 9.18: Packets Window

After analysis, the Packets Bar looks like the following (see the following figure):

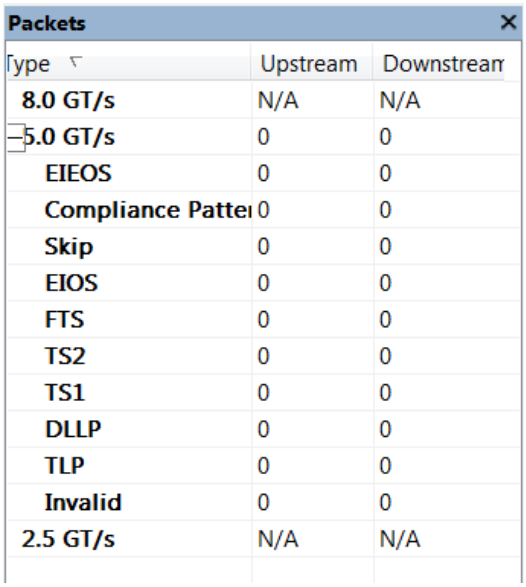


Figure 9.19: Packets Bar After Analysis

9.13 Decoding Bar

If you select them in the data view, or search or jump locates a feature, BitTracer mode displays ordered sets and packets in the Decoding dialog (see Figure 9.20 on page 606).

- **Logical view** is identical to CATC Trace format.
- **Specification view** provides a more elementary display. The Specification view includes an option to display data in hex or binary format.

Note: Packets and ordered sets translate directly to this view from data capture and use any post-capture skew manipulations you add, or use natural lane-to-lane skew present on the link if you have not added post-capture skew manipulations. Typically, you would perform an Auto De-Skew before viewing ordered sets and packets in this view.

Use the left and right arrows to search for the next or previous symbol type.

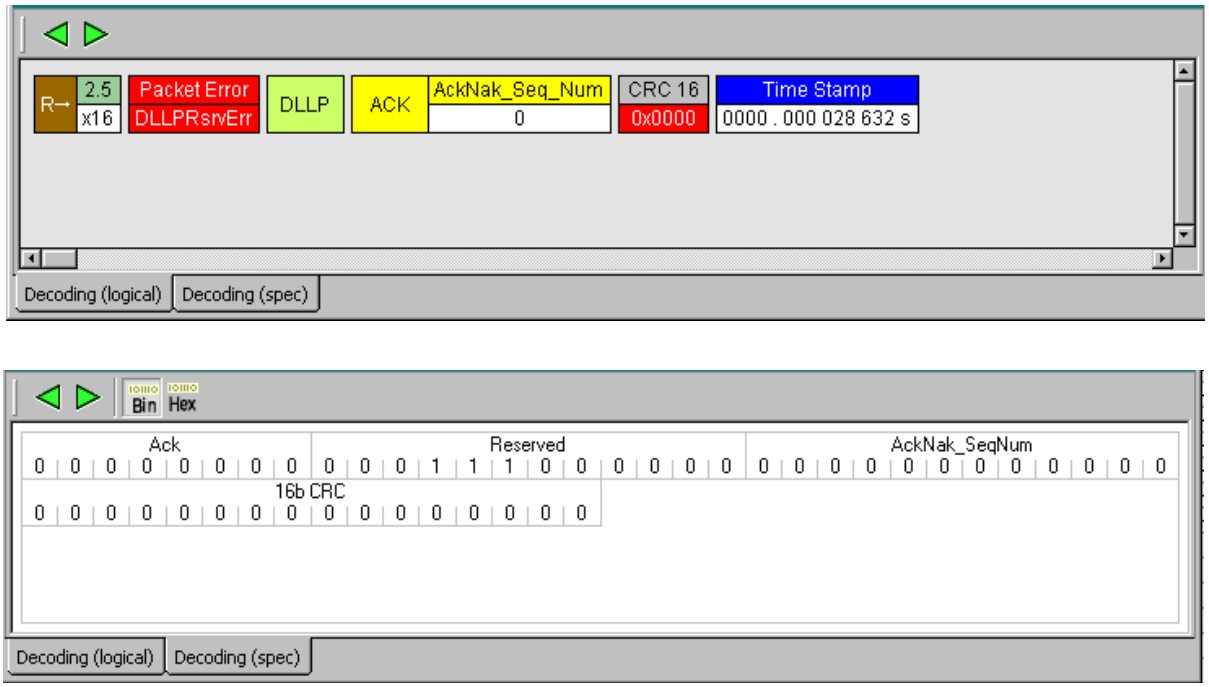


Figure 9.20: Decoding Dialog

9.14 Search

To search, use the Search toolbar.



Figure 9.21: Search Toolbar

Clicking the **Search** icon displays the Search dialog (see Figure 9.22 on page 607).

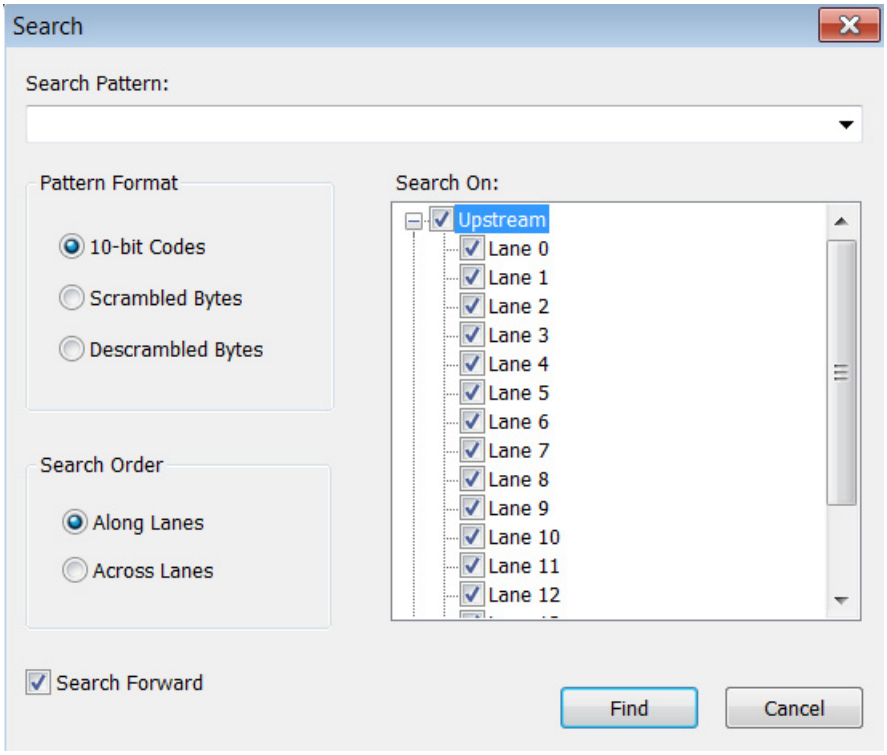


Figure 9.22: Search Dialog

You can copy data shown in the BitTracer display across a lane (horizontally) or across multiple lanes (vertically), and then paste it into the Search Pattern window.

The Search Pattern window stores previous search values, which you can recall by selecting the Search Pattern drop-down button.

In the Pattern Format section, select to search in 10-bit Codes, Scrambled Bytes, or Descrambled Bytes format.

In the Search Order section, select to search Across Lanes (multiple lanes, vertically) or Along Lanes (individual lanes, horizontally).

To define the direction (upstream or downstream) and the lanes on which to search, use the Search On section.

9.15 Link Configuration

Use the toolbar icon or right-click in the data views to display the Link Configuration dialog (see the following figure). This dialog allows you to associate logical lanes with physical lanes, thereby providing support for lane bifurcation (multiple logical links on the same physical link).

After logical lanes map to physical lanes, BitTracer mode reconfigures the display to show the selected logical link (and the logical link width, as the link width selected in the dialog).

Use the arrows to force symbol time skew on any lane.

Use the polarity checkbox to invert lane polarity on the selected lane or use the **+/-** toolbar icon.

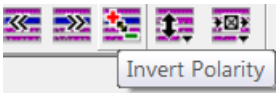


Figure 9.23: Invert Polarity

Use the scrambling option to select a scrambling algorithm, as per specification 1.0a or legacy specification 1.0.

Select **Edit > Edit Link** or click the  icon to display the Link Configuration for Upstream dialog (see Figure 9.24).

Note: This dialog applies to one direction at a time (upstream or downstream). Left-click in the direction in the data display to edit the configuration for that direction.

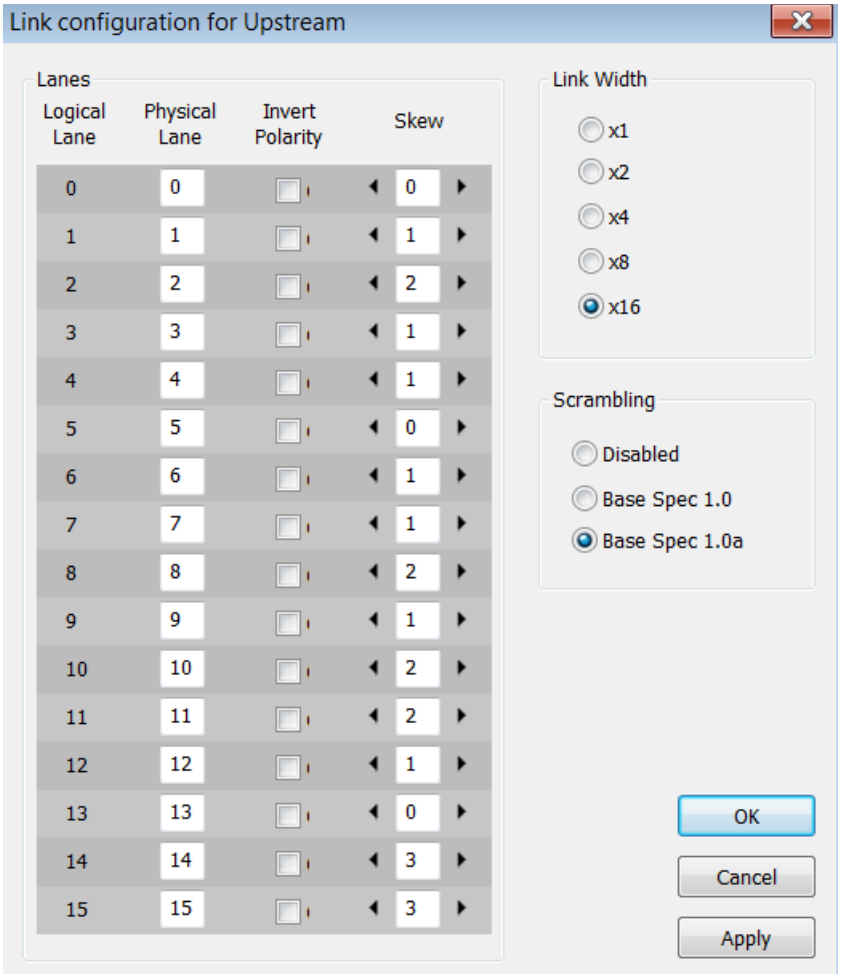


Figure 9.24: Link Configuration for Upstream Dialog

As you perform operations that affect display configurations, the application records them. To undo or redo operations, use the Undo and Re-do icons on the toolbar.

9.16 Export of BitTracer Capture to CATC Trace Format

You can export BitTracer captures to standard CATC Trace file formats, selecting the **Export** option from the File menu.

Note: If the bit trace is not deskewed, you should use the Auto De-skew feature before using the export feature.

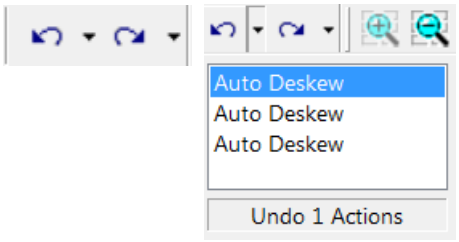


Figure 9.25: Auto Deskew Function

The exported CATC Trace keeps association information with the original BitTracer file. Such traces scroll synchronously when you select the **Synchronize Traces** option in the Windows menu.

You can navigate between BitTrace and CATC Trace using the **Show in Trace View/ Show Packet in Raw Trace** context menu.

9.16.1 Exports Involving Multiple Logical Links on One Physical Link

If a single BitTrace capture contains more than one logical link, you can export each logical link to CATC Trace format. You may then cascade or tile the various BitTracer exports, which then scroll together in linked fashion, along with the original BitTracer file. The Export dialog provides options to export a limited range within the BitTrace capture and to automatically open the exported capture in CATC Trace format.

9.16.2 Export To CSV Text

Select **File > Export > Packets to CSV Text** to display the Export Packets to comma delimited text dialog. Select desired options from the From and To Segment, Marker and Time drop-down lists (see Figure 9.26 on page 610).

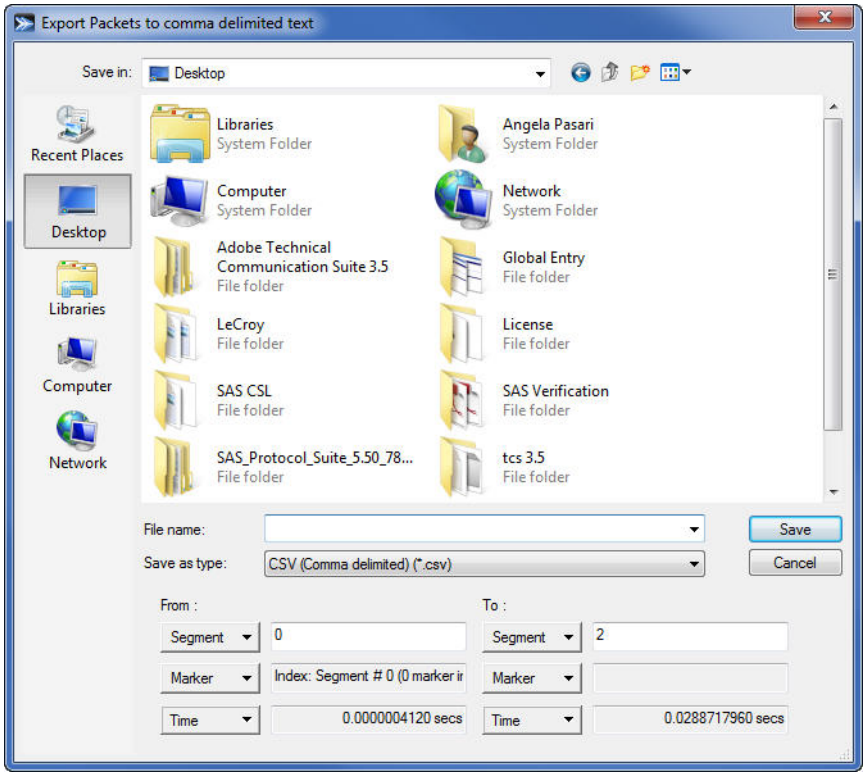


Figure 9.26: Export Packets to Comma Delimited Text Dialog

9.16.3 Exporting Data from Bit Tracer to a Trace File

Matching Link Width

Note: To export data correctly from Bit Tracer to a Trace file the Link Width of the recorded data traffic must match the Link Width of the Trace. If the Link Width is altered the result will be a Trace with errors in it.

In the example below, a raw data file is loaded with a recorded Link Width of x16 (see Figure 9.27).

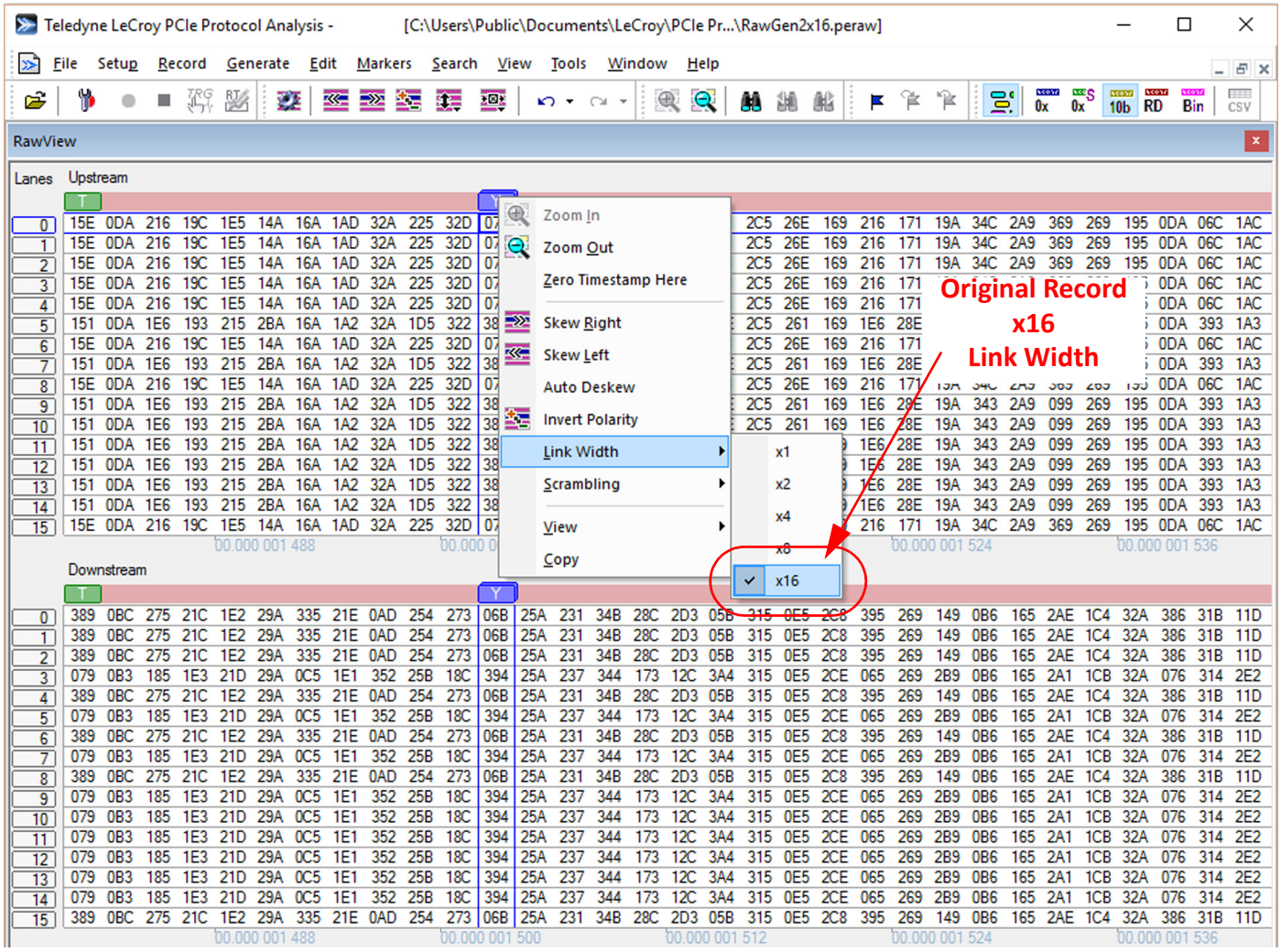


Figure 9.27: Raw Data File Loaded with x16 Link Width

Then the Raw Data File is Exported to Trace (see Figure 9.28 on page 612).

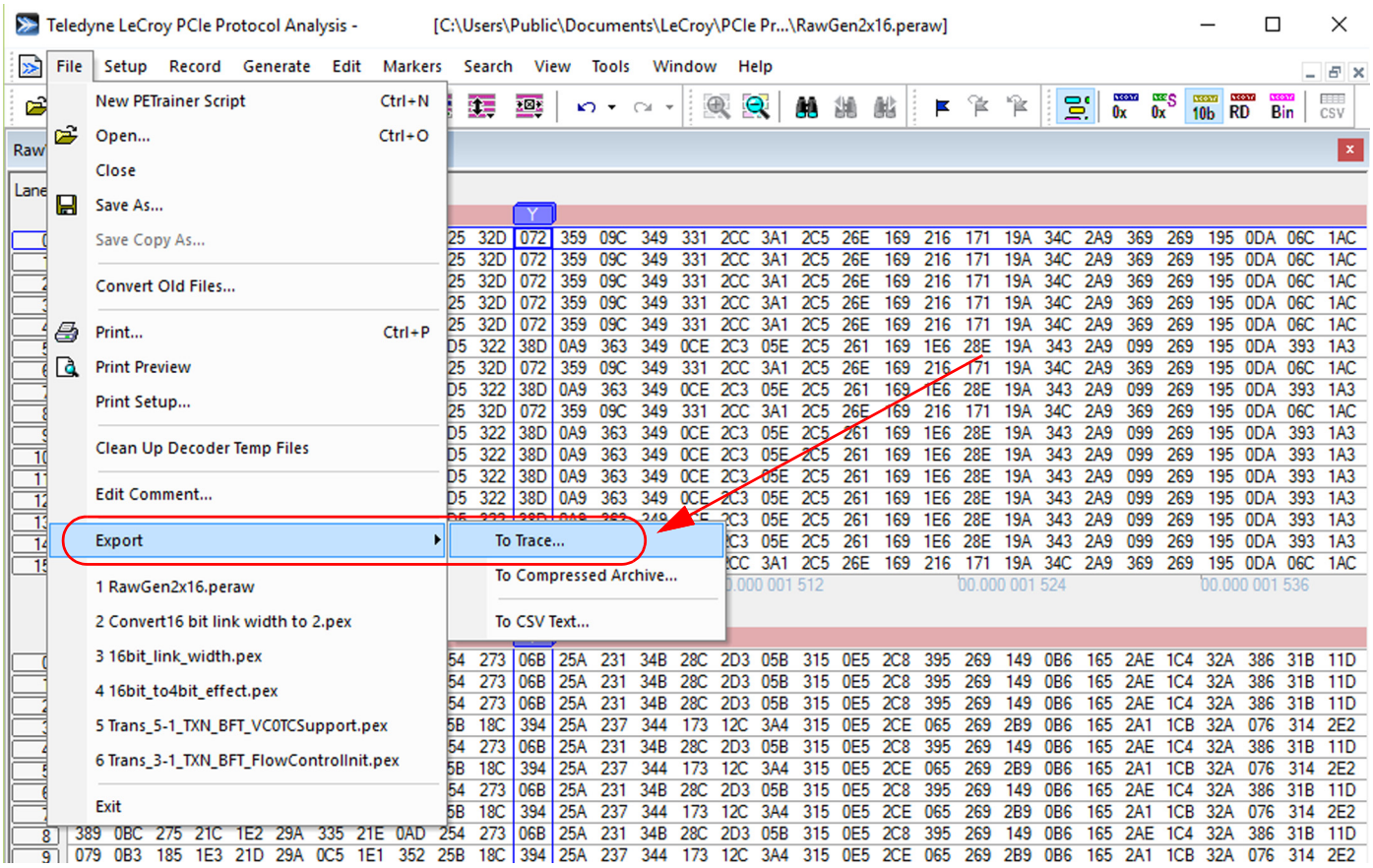


Figure 9.28: Raw Data File Exported from Bit Tracer to Trace File

The resulting trace file shown in CATC View (see Figure 9.29 on page 613).

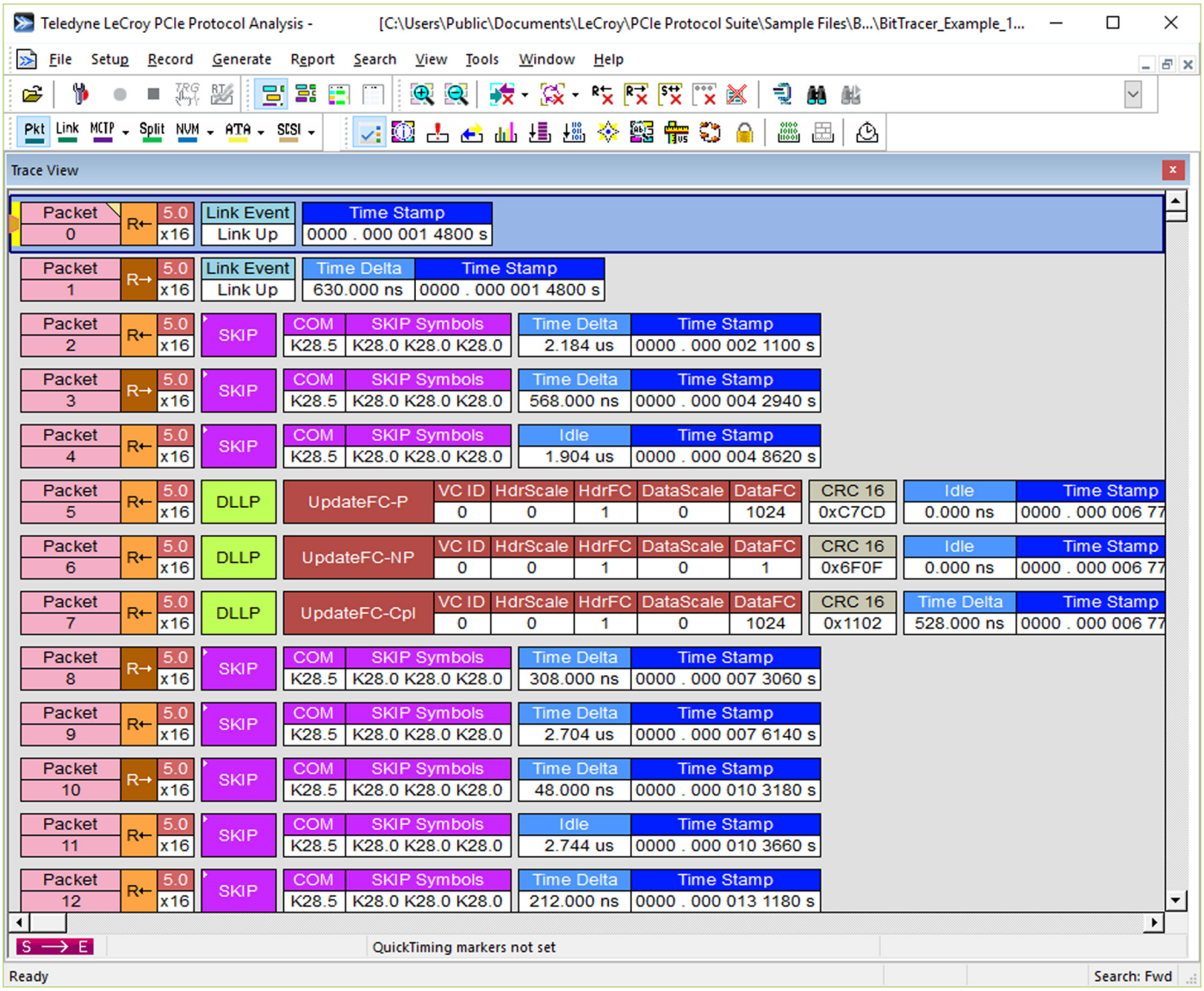


Figure 9.29: Exported Trace File from Bit Tracer

Changing Link Width from Original Recording

If you change the Link Width of the data traffic from the original recording and Export that data traffic to a Trace, the Trace will be decoded with errors. See Figure 9.30 and Figure 9.31 on page 615.

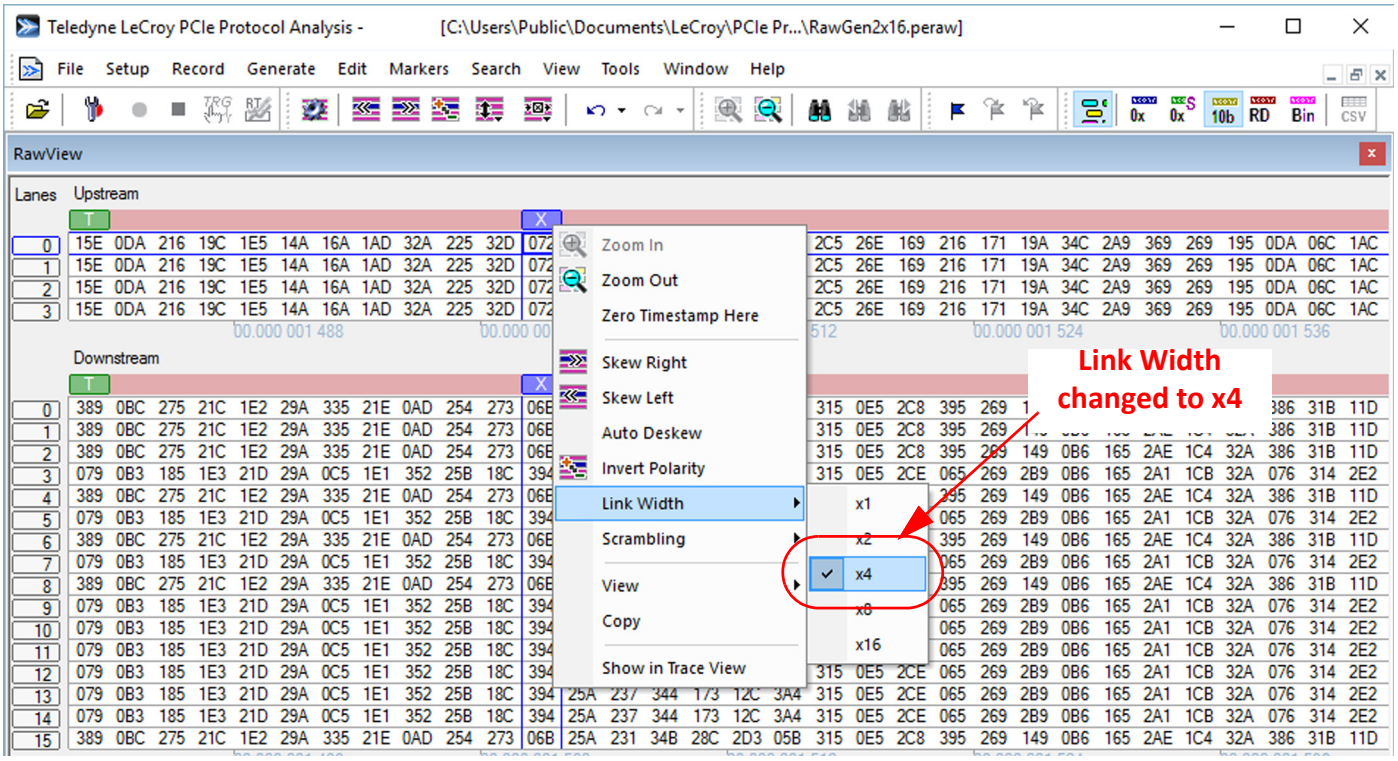


Figure 9.30: Link Width Changed From x16 to x4

Exporting the Data Traffic to a Trace will result in decoding errors (see Figure 9.31 on page 615.

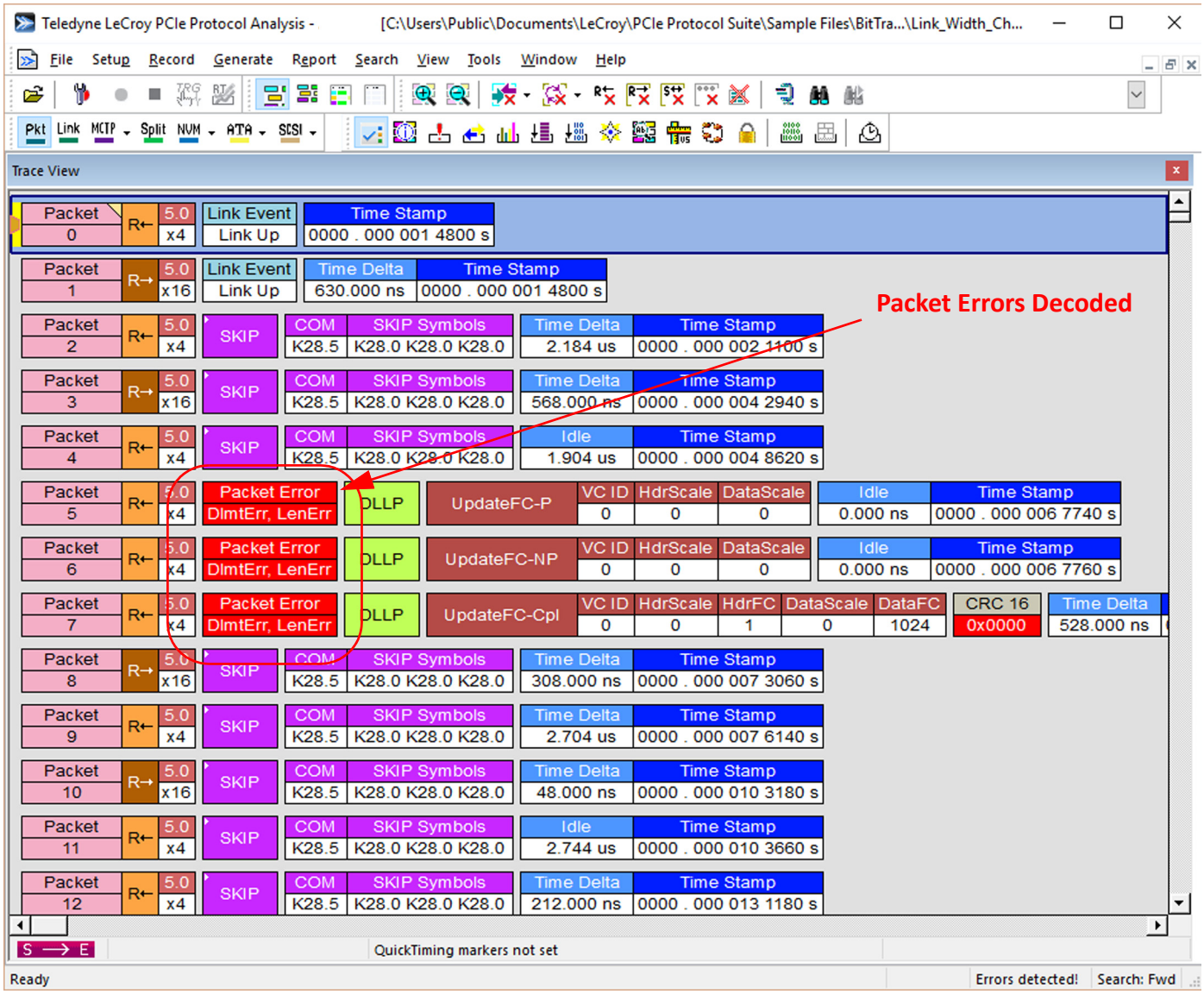


Figure 9.31: Export Data File with Changed Link Width (from x16 to x4)

9.17 Compressing and Expanding the Data View

You can compress (zoom out) the horizontal timing of the displayed data to view higher-order link behaviors. You can expand (zoom in) to examine higher-resolution views.

To zoom in or zoom out, right-click the data view, then select a command or select a zoom icon on the toolbar.



Figure 9.32: Compressing and Expanding the Data View

Alternatively, to zoom in, left-click and drag across a desired range of data.

9.18 Opening and Saving BitTracer Captures

You can save BitTracer captures in various file types.

You can collate and archive these files for transport, using the **Export to Compressed Archive** feature in the File menu.

The main BitTracer files have a ***.peraw** extension.

You can open these files in the PCIe Protocol Analysis application using the **File > Open** command.

Chapter 10

Reports and Tools

Reports assist you in analyzing traffic recorded by the Analyzer. The available reports are:

- **Trace Information**: To view general information about the CATC Trace file. See "Trace Information" on page 621.
- **Error Summary**: To view a count of errors in a CATC Trace file. See "Error Summary" on page 624.
- **Traffic Summary**: To view a summary of protocol-related information in the CATC Trace file summary information about a selected group of items in the CATC Trace file (such as a count of particular frame or packet types). See "Traffic Summary" on page 632.
- **Bus Utilization**: To display information on bandwidth usage for the transmit and receive channels. See "Bus Utilization" on page 640.
- **Link Tracker**: Displays a detailed chronological view of events. See "Link Tracker" on page 648.
- **Data Flow**: Shows marker, packet, direction, type, length, address, payload, handshake, and timestamp information. See "Data Flow Window" on page 653 and "Flow Control Tracking" on page 655.
- **Trace Navigator**: Navigates within the CATC Trace to view the location of errors and triggers, narrow the range of traffic on display, and jump to any point in the CATC Trace. See "Using the CATC Trace Navigator" on page 656.
- **Detail View**: Shows the detail view of the selected packet. See"Detail View" on page 662.
- **LTSSM Flow Graph**: Shows a state diagram of bus activity. See "LTSSM Flow Graph" on page 663
- **Packet Header**: Shows packet header information. See "Packet Header Bar" on page 667
- **Packet Data**: Shows packet or transaction payload. See "Packet Data Window" on page 667.
- **Configuration Space**: Displays a Configuration Space. See "Configuration Space View" on page 668.
- **Metrics**: Measures key operating parameters. See "Using Unit Metrics" on page 672 through "Show Metrics in the Bus Utilization Window" on page 676.
- **Real Time Statistics**: To display statistical information for the channels. See "Real-Time Statistics Window" on page 679.
- **Memory I/O Space Editor**: Displays the Memory I/O Space Editor dialog. See "Memory I/O Space Editor" on page 685.

- **TC to VC Mapping**: To display how Traffic Classes are mapped to Virtual Channels (to simplify navigation) and how the CATC Trace display was changed (for example, in Split Transactions). See "TC to VC Mapping" on page 685.
- **Timing Calculations**: To view timing measured between two events set within the CATC Trace file. See "Timing and Bus Usage Calculations" on page 686.
- **PCIe SSD Base Mapping**: Displays the PCIe SSD Base Address dialog. See "PCIe SSD Base Address Mapping" on page 697.
- **Run Verification Scripts**: Allows you to check errors, link transactions, split transactions, metrics, ordered sets, replays, DLLPs, and TLPs. See "Running Verification Scripts" on page 708.
- **Trace Expert**: Generates reports on Performance Analysis, Trace Analysis Statistics, Error Reports and Trace Information. See "Trace Expert" on page 713.

Reports are available from the Report menu and buttons on the Tool bar. Tools are available from the Tools menu.

10.1 Trace Information

The Trace Information window provides a summary on the currently displayed file.

Select **Reports > Trace Information**  to display the Trace Information window.

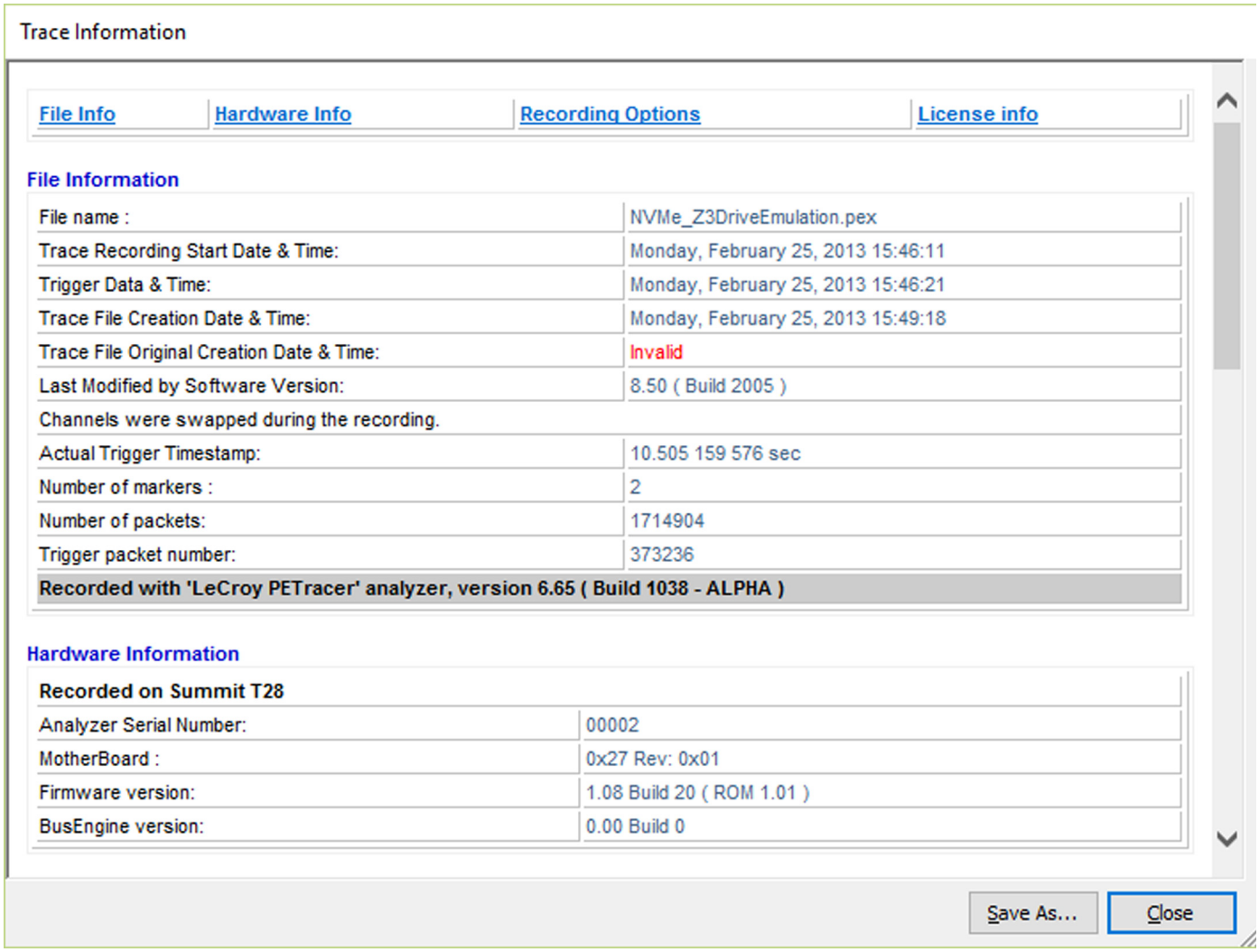


Figure 10.1: Trace Information Window (1)

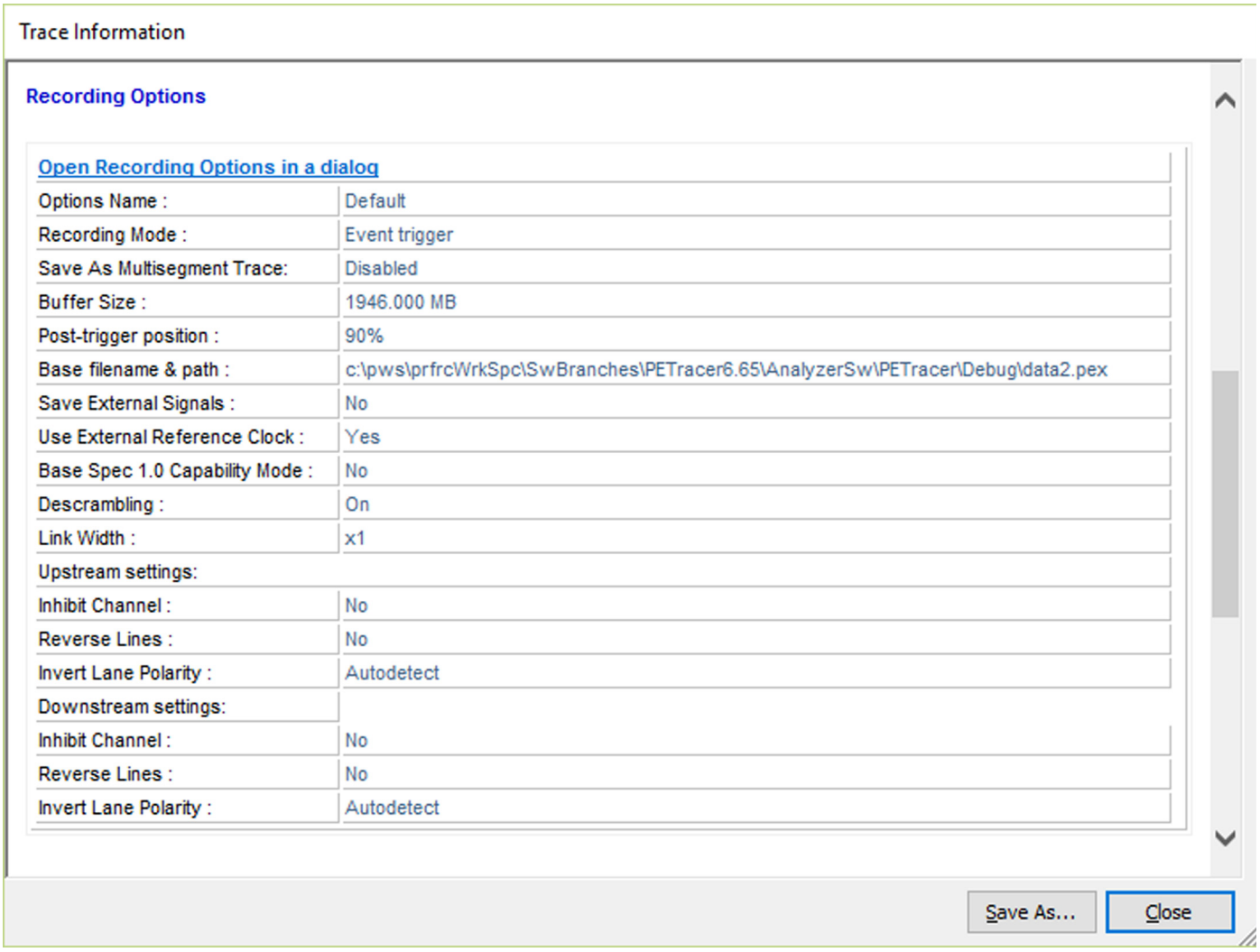


Figure 10.2: Trace Information Window (2)

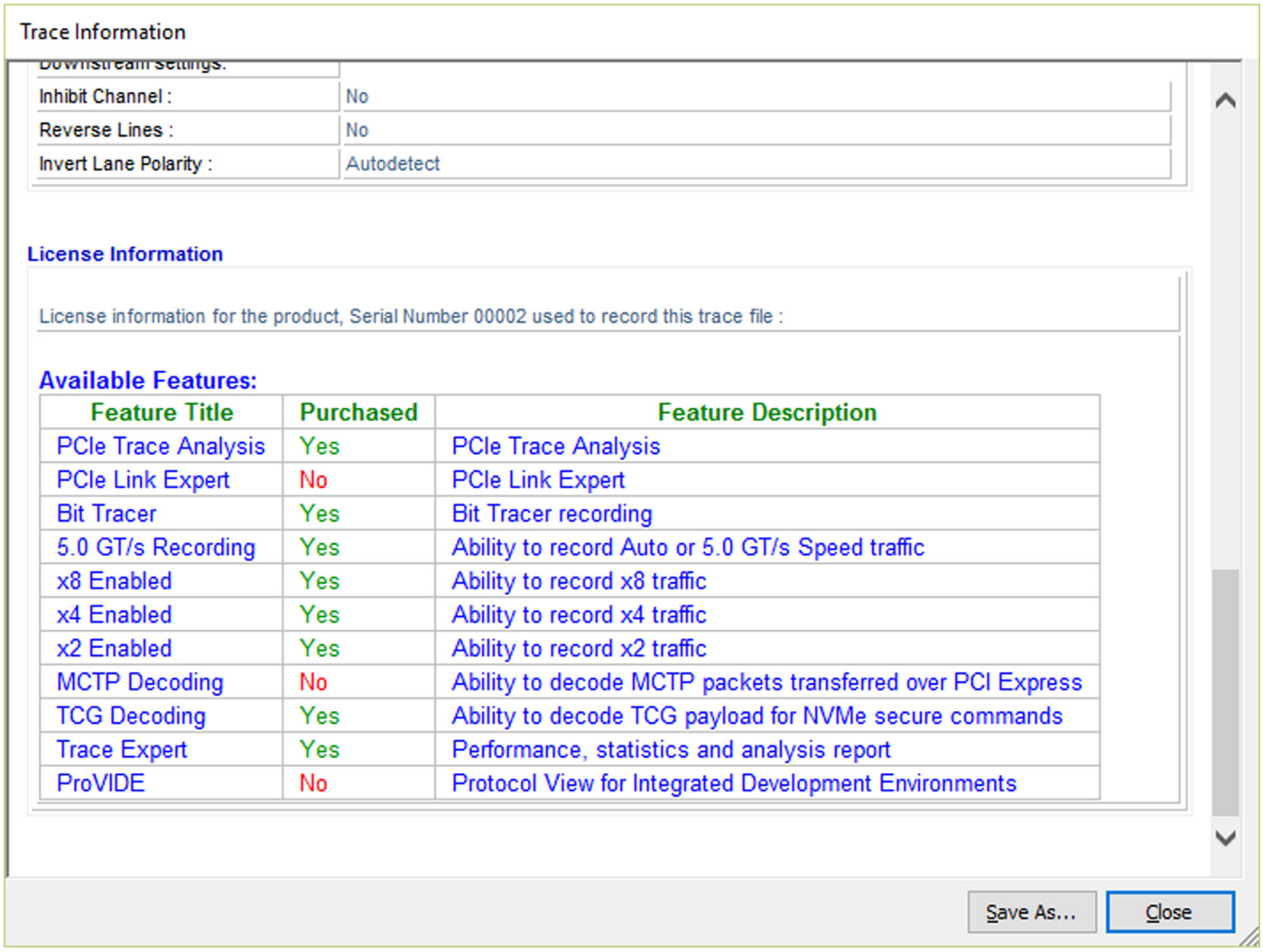


Figure 10.3: Trace Information Window (3)

10.2 Error Summary

The Error Summary dialog displays the number of errors for each event and the packet containing the errors.

Select **Reports > Error Summary** or click  to open the Error Summary dialog (see Figure 10.4 on page 624).

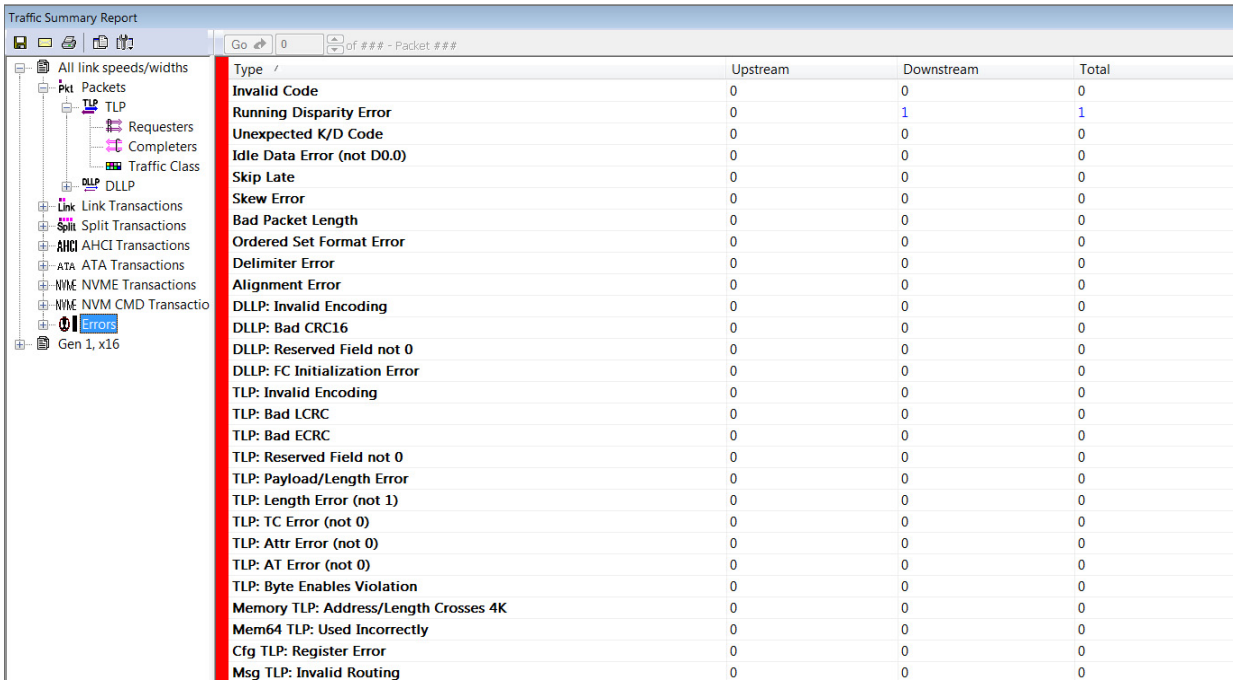


Figure 10.4: Error Summary Dialog.

10.2.1 Error Summary for Storage Protocols

After decoding a trace for the corresponding storage protocol, the CATC Trace will have a summary ready of the errors found for the trace. Example: The AHCI Error Summary dialog is a sub-entry for the main Error Summary dialog. It displays the number of errors for each AHCI transaction containing the errors.

Select **Reports > Error Summary** to open the Error Summary dialog.

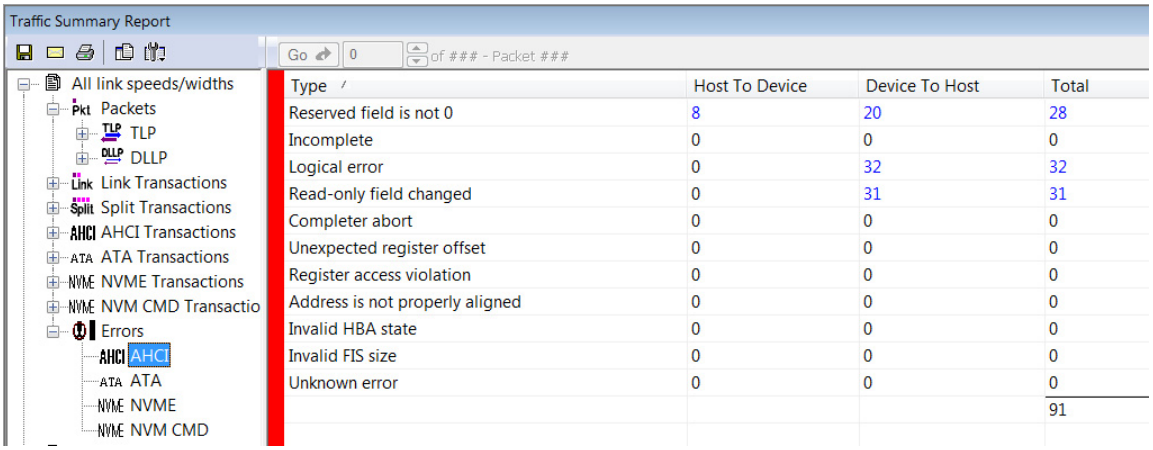


Figure 10.5: AHCI Error Summary Dialog.

The five types of AHCI errors are describe below:

Reserved Field not Zeroes

One or more fields inside the AHCI transaction are not filled with all 0s. The AHCI specification states that all reserved fields and registers must be filled with 0s.

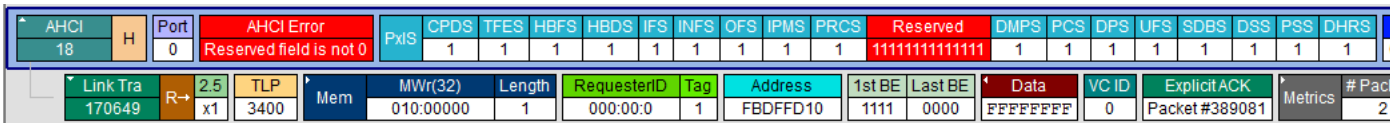


Figure 10.6: Reserved Field Not Filled With Zeroes

Note: Reserved fields for AHCI level are not displayed when filled with all 0s.

Incomplete

The AHCI transaction does not contain enough data or lower-level transactions (Link or Split) are marked as incomplete.

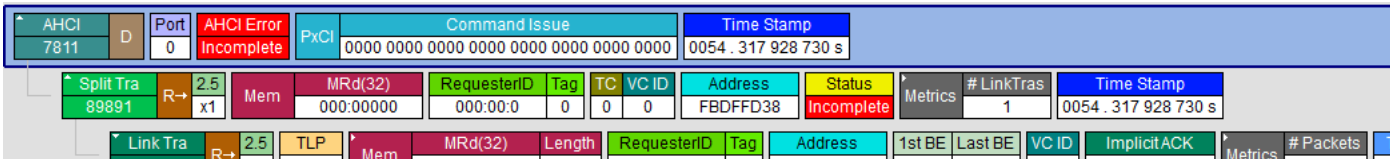


Figure 10.7: Incomplete

Logical Error

One or more fields are in an inconsistent state relative to the other fields in the same or other registers.

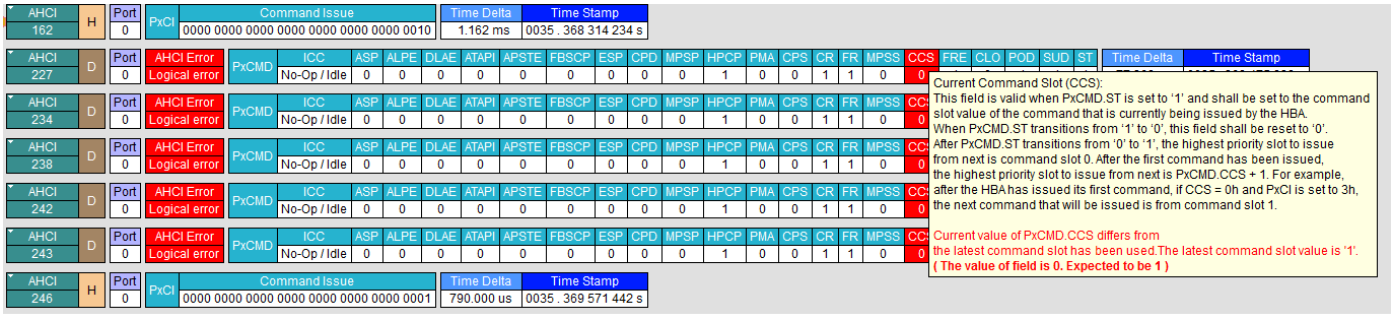


Figure 10.8: Logical Error

Read-only Field Changed

The value of the read-only field differs from the previous one.

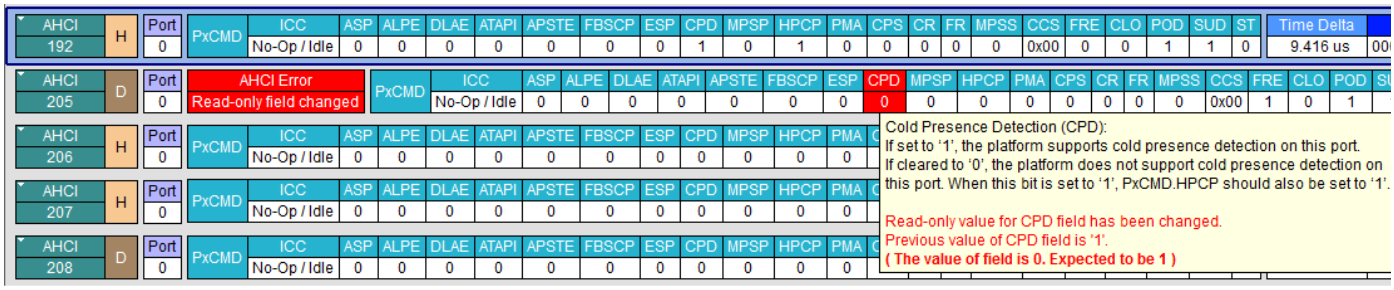


Figure 10.9: Read-only Field Changed

Unknown

The AHCI decoder is unable to decode a particular transaction correctly. This can be caused by missing base address information. Make sure the enumeration phase has been recorded in the trace or provide base address information by selecting **Tools > PCIe SSD Base Address Mapping**.

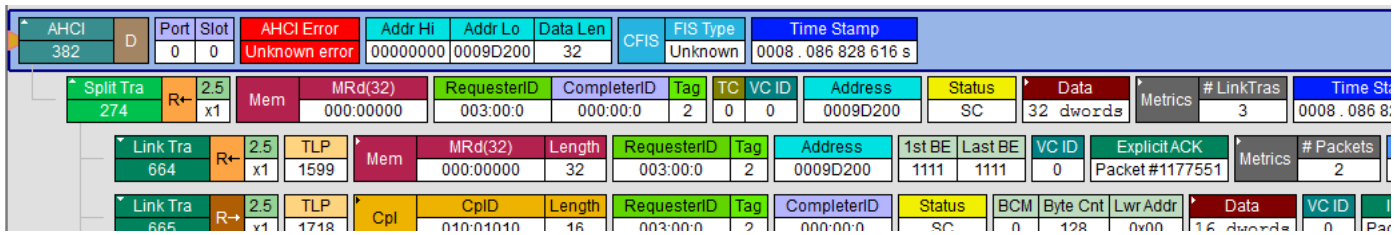


Figure 10.10: Unknown

Checks for Logical error and Read-only field depending on the values obtained from previous registers. It can result in false-positive or false-negative detections in case of partially saved trace file. The AHCI transaction can be marked as incomplete in case of saving a portion.

10.2.2 Error Summary for Storage Protocols -- NVMe

The NVMe sub-entry of the Error Summary dialog displays the number of NVMe errors found while decoding the trace at the NVMe level as shown in Figure 10.11, Figure 10.12 and Figure 10.13.

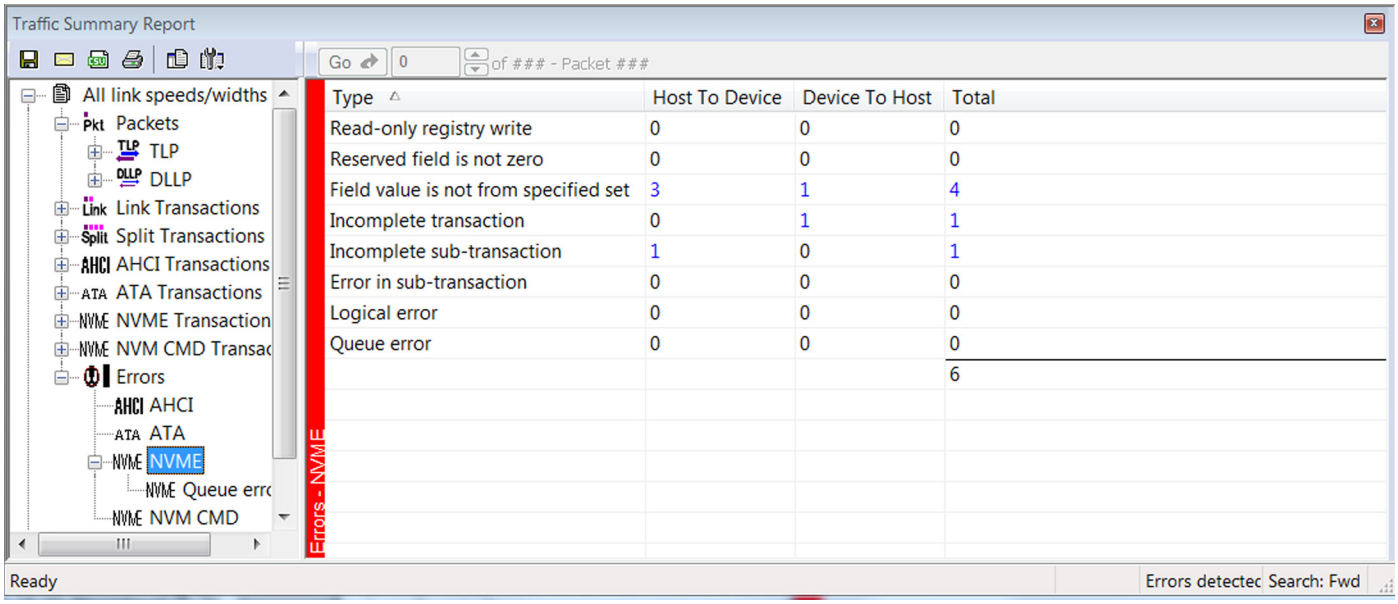


Figure 10.11: NVMe Errors After Decoding the Trace

10.2.2.1 Types of NVMe Errors:

1. Read-only register write: An attempt to write to a read only register was made.

2. Reserved field is not zero: One (or more) of the fields set as reserved in the current spec revision is not zero - this could indicate a problem such as reversed bit ordering, or it could be intentional such as working with unreleased version of the next specification or user debug bits.

3. Field values is not from specified set: There is a value used in the indicated field that is not used in the currently released specification. If working with an early release of the next specification, or a proprietary feature this could be valid otherwise it would normally indicate a problem.

4. Incomplete transaction: One or more of the steps for a NVMe transaction is missing eg no completion queue entry after submission queue submission.

5. Incomplete sub-transaction: Some NVMe transactions have sub states and this indicates that within a substate part of the expected sequence is missing.

6. Error is sub-transaction: Some NVMe transactions have sub states and this indicates that within a substate an error in the sequence or value was detected.

7. Logical error: Groups any potential logic errors, such as declaring a payload of 64 bytes (0) but sending 0 bytes.

8. Queue error: There was an error in writing to the queue. Eg writing to a queue before it was created or trying to write additional entries to a queue that was full. There are a series of specific errors available on the NVMe Queue error report.

10.2.3 NVMe Queue Errors

The NVMe Queue Error sub-entry of the Error Summary dialog lists NVMe errors which are specific to interacting with the NVMe queues.

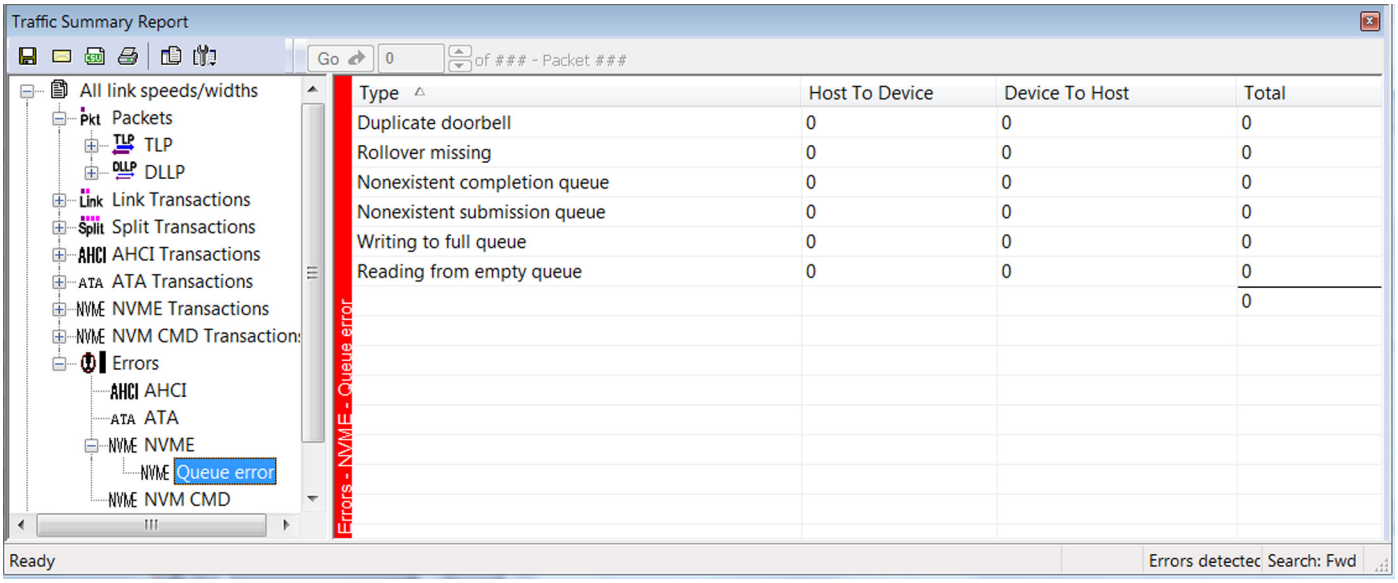


Figure 10.12: NVMe Errors Specific to NVMe Queues

10.2.3.1 Types of NVMe Queue Errors

1. Duplicate doorbell: The same doorbell was used consecutively.

2. Rollover missing: The queue rollover was missed.

3. Nonexistent completion queue: A completion queue was attempted to be used before it had been created.

4. Nonexistent submission queue: A submission queue was attempted to be used before it had been created.

5. Writing to full queue: All possible entries in the queue were previously filled and have not been cleared yet and the current write would add more entries than the declared size of the queue.

6. Reading from empty queue: A queue has had no entries submitted or all previous entries have already been read such that there are no entries in the queue to be read, however a read was attempted even though there are no entries.

10.2.4 NVMe CMD Errors

The NVMe CMD sub-entry of the Error Summary dialog lists errors which are specific to NVMe command decoding. See Figure 10.13

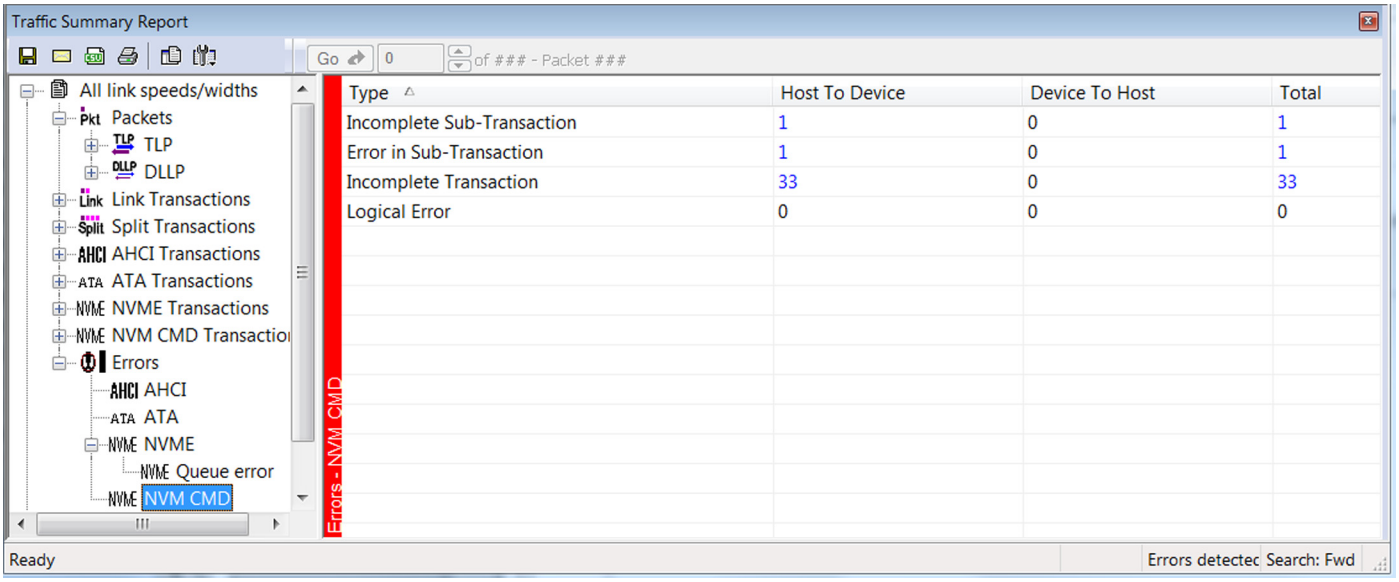


Figure 10.13: NVMe Errors Specific to NVMe Commands

10.2.4.1 Types of NVMe CMD Errors

1. Incomplete Sub-Transaction: Some NVMe transactions have sub states and this indicates that within a substate the required sequence was not completed.

2. Error in Sub-Transaction: Some NVMe transactions have sub states and this indicates that within a substate an error in the sequence or value was detected.

3. Incomplete Transaction: One (or more) of a transactions steps are missing, example shows a transaction missing the doorbell and the preceding one that has all the transaction steps. See Figure 10.14.

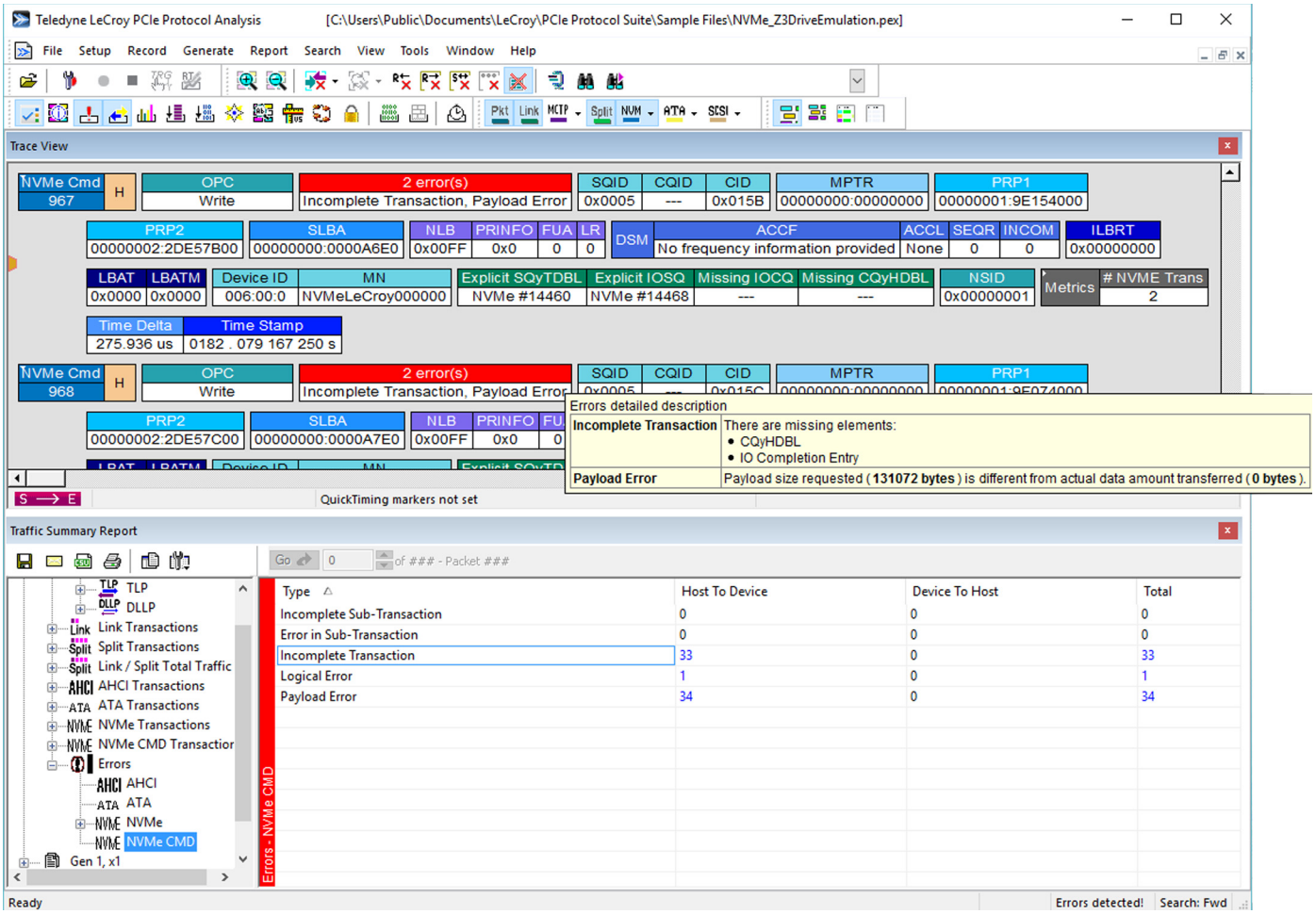


Figure 10.14: NVMe CMD Error -> Incomplete Transaction with Tooltip

4. Logical Error: Groups any potential logic errors, such as declaring a payload of 64 bytes (0) but sending 0 bytes. See Figure 10.15.

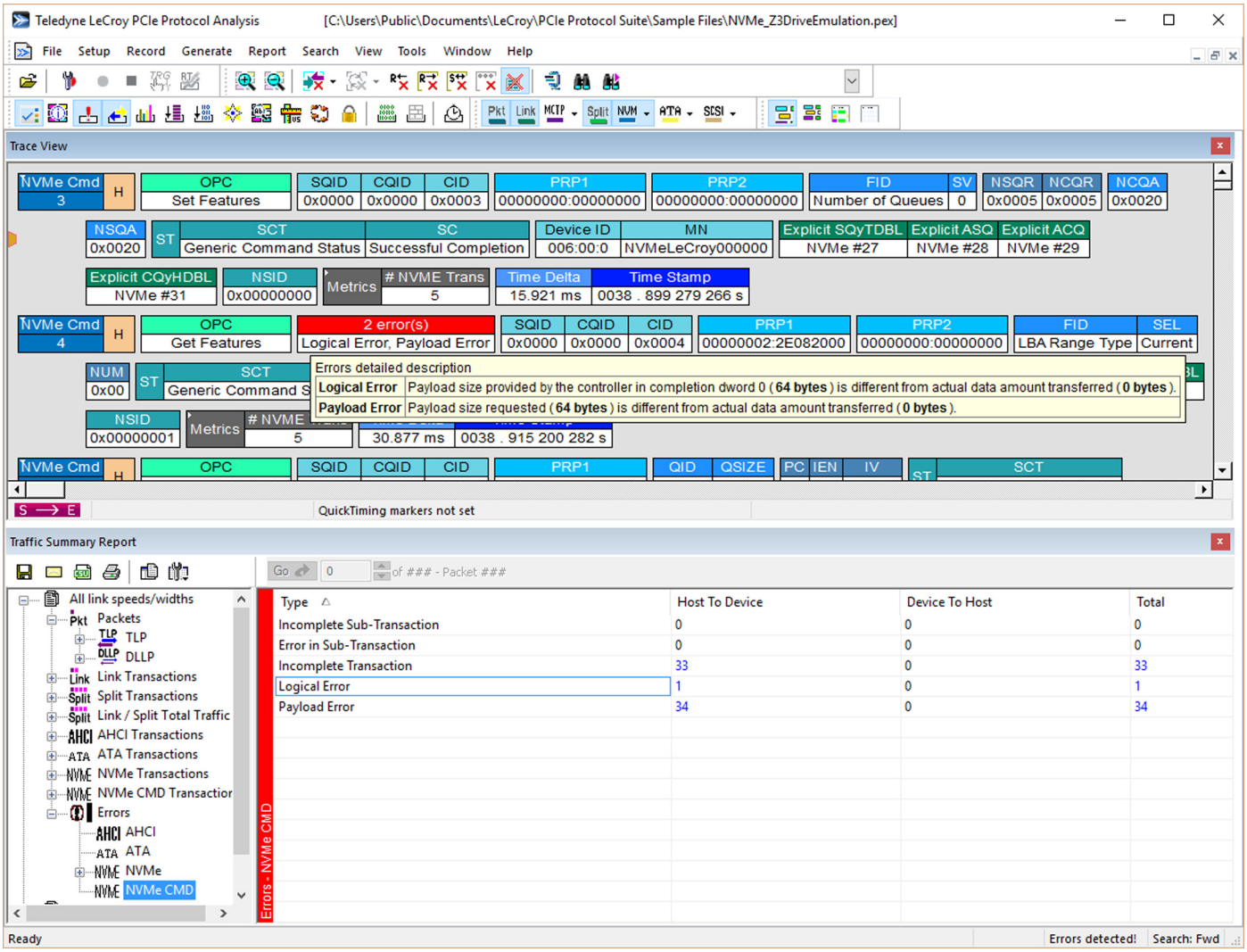
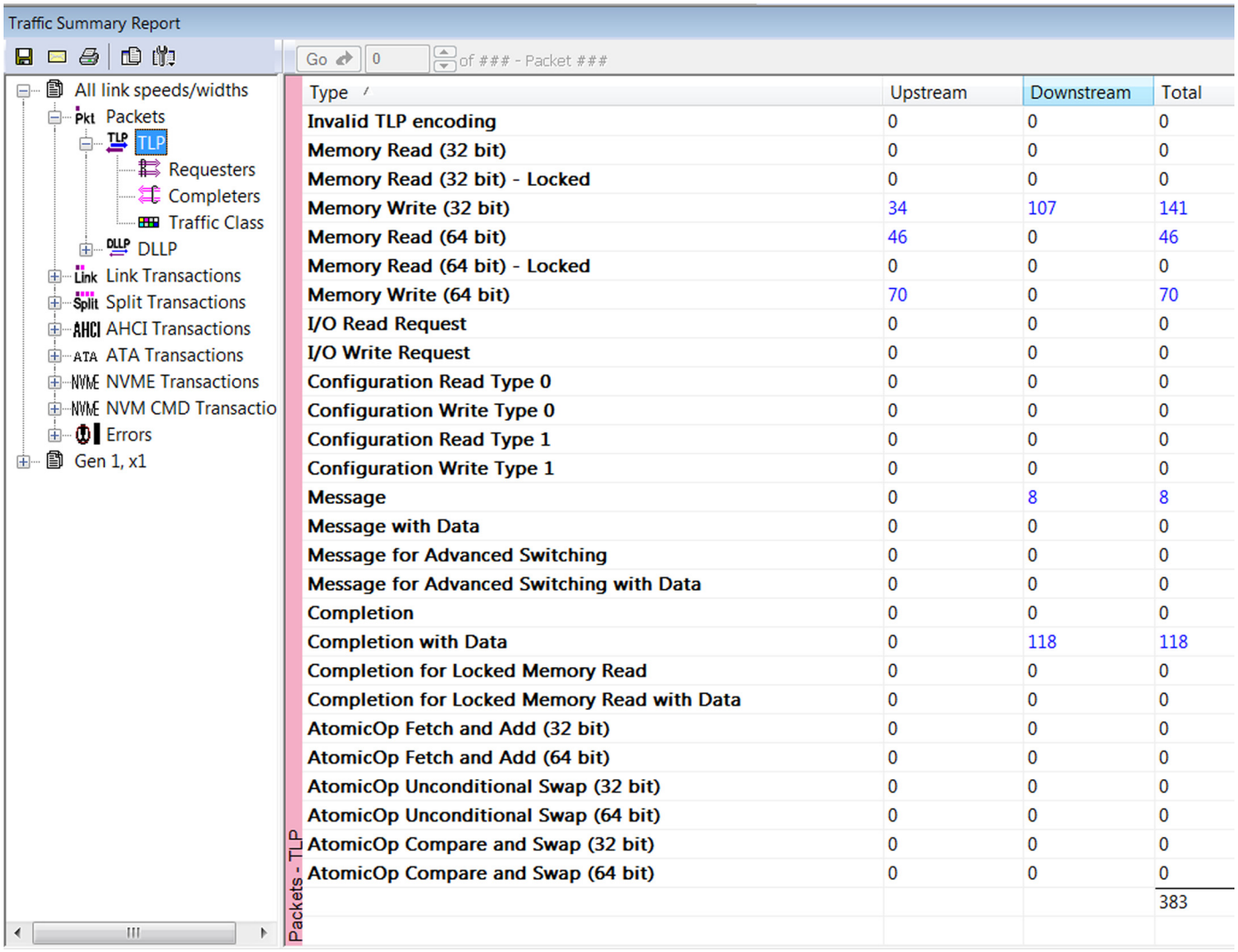


Figure 10.15: NVMe CMD Error -> Logical Error with Tooltip

10.3 Traffic Summary

The Traffic Summary window summarizes the traffic in the current CATC Trace. The left side of the window displays a tree of protocol levels. The right side displays a summary of traffic for the displayed levels.

Select **Reports > Traffic Summary** or click  to display the Traffic Summary window.



Type	Upstream	Downstream	Total
Invalid TLP encoding	0	0	0
Memory Read (32 bit)	0	0	0
Memory Read (32 bit) - Locked	0	0	0
Memory Write (32 bit)	34	107	141
Memory Read (64 bit)	46	0	46
Memory Read (64 bit) - Locked	0	0	0
Memory Write (64 bit)	70	0	70
I/O Read Request	0	0	0
I/O Write Request	0	0	0
Configuration Read Type 0	0	0	0
Configuration Write Type 0	0	0	0
Configuration Read Type 1	0	0	0
Configuration Write Type 1	0	0	0
Message	0	8	8
Message with Data	0	0	0
Message for Advanced Switching	0	0	0
Message for Advanced Switching with Data	0	0	0
Completion	0	0	0
Completion with Data	0	118	118
Completion for Locked Memory Read	0	0	0
Completion for Locked Memory Read with Data	0	0	0
AtomicOp Fetch and Add (32 bit)	0	0	0
AtomicOp Fetch and Add (64 bit)	0	0	0
AtomicOp Unconditional Swap (32 bit)	0	0	0
AtomicOp Unconditional Swap (64 bit)	0	0	0
AtomicOp Compare and Swap (32 bit)	0	0	0
AtomicOp Compare and Swap (64 bit)	0	0	0
			383

Figure 10.16: Traffic Summary Dialog

Buttons at the top of the Traffic Summary window change the display format and enable data to be exported to email, file, or the printer.

10.3.1 Traffic Summary for Storage Protocols

After decoding a trace for the corresponding storage protocol, the CATC Trace will have a summary ready of the commands existing in the trace. Example: The AHCI Traffic Summary window summarizes the AHCI traffic in the current CATC Trace. The right side displays a summary of AHCI transactions and errors.

Select **Reports > Traffic Summary** to open the Traffic Summary dialog.

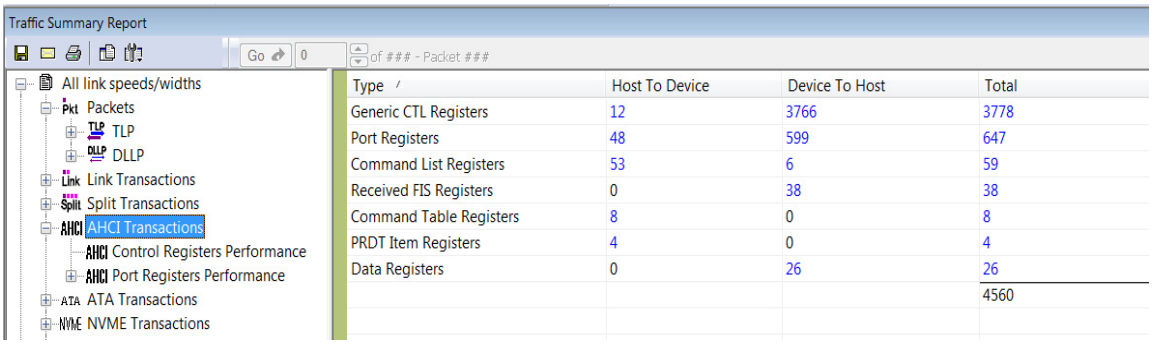


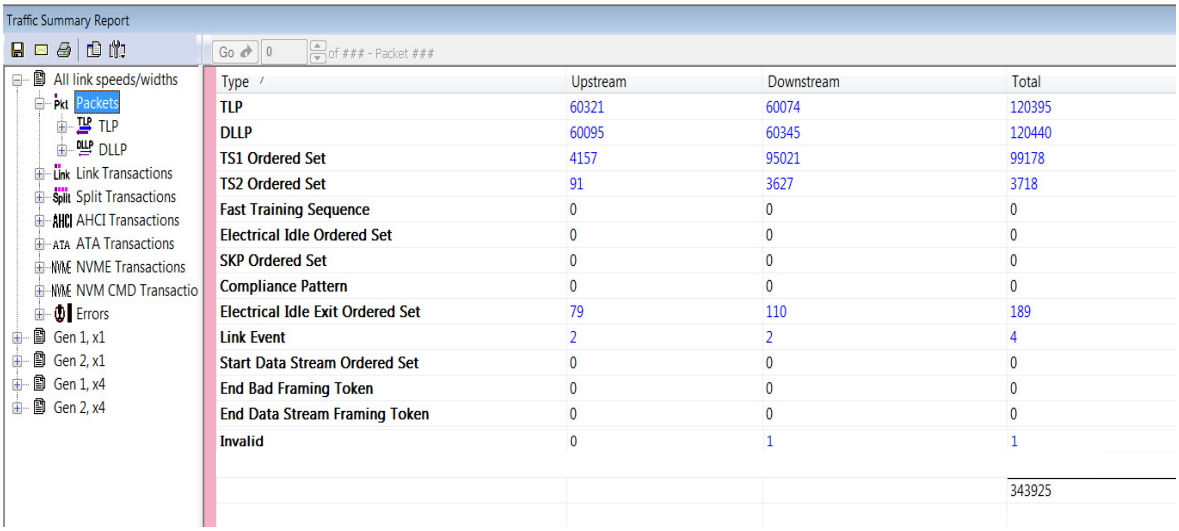
Figure 10.17: AHCI Traffic Summary Dialog

10.3.2 Using the Traffic Summary Window to Search the CATC Trace

You can use the Traffic Summary window to move the CATC Trace to packets of interest:

1. Click one of the numbers in the right side of the Traffic Summary window (see the following figure).

   The CATC Trace jumps to the first instance of the selected protocol.



2. Click the **up** or **down** arrows 

. The CATC Trace jumps forward or backward through the display to the next instance of selected protocol level.

10.3.3 NVMe Queue Time Metrics

NVMe Queue Time Metrics can be seen in the Traffic Summary, which includes all of the Doorbell Metrics (see Figure 10.18).

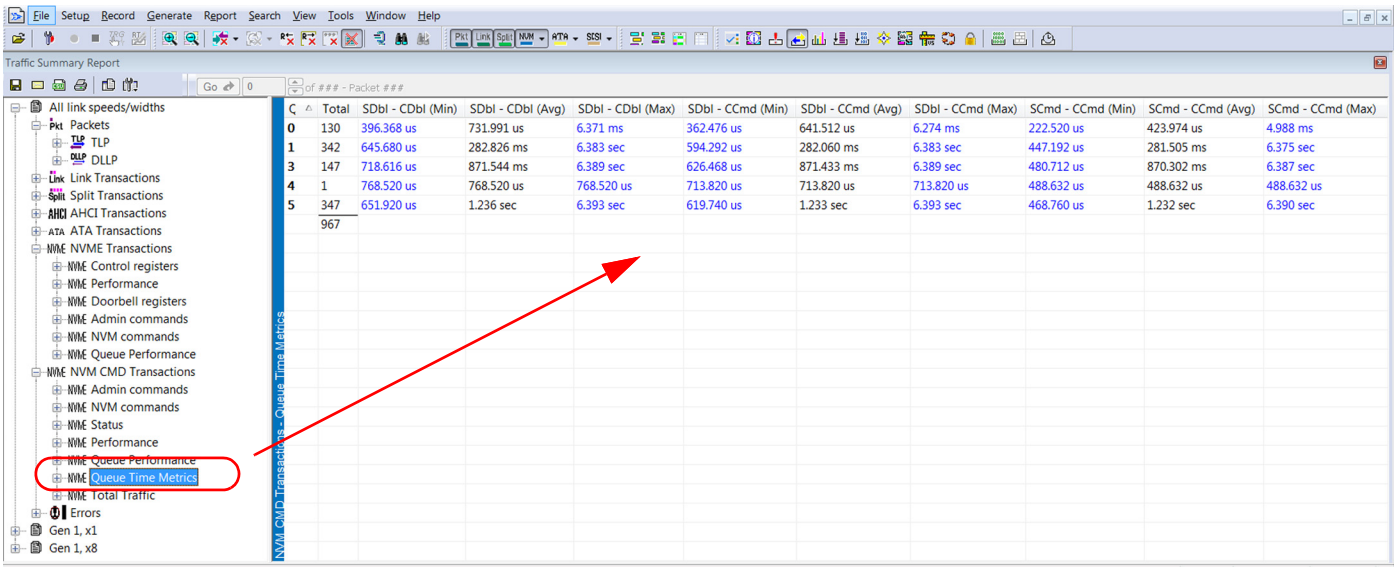


Figure 10.18: NVMe Queue Time Metrics for Doorbell Operations

10.3.3.1 NVMe Queue Time Metrics Defined (Commands/Transactions)

TABLE 10.10: NVMe Queue Time Metrics (Commands/Transactions)

NVMe Queue Time Metrics	Definition
# NVME Trans	Number of NVME Transactions - the total number of NVME Transactions that compose this NVME Command
# Link & Split Trans	Number of Link & Split Transactions - the total number of Link & Split Transactions that compose this NVME Transaction
Response Time	Time it took to transmit this NVME Command/Transaction on the link, from the beginning of the first packet in the NVME Command/Transaction to the end of the last packet in the NVME Command/Transaction
Latency Time	Time measured from the end of transmission of the NVMe submission command to start of transmission of the NVMe completion command
Pld. Bytes	Payload: Number of payload bytes this NVME Command transferred
Thrpt MB/s	Data Throughput: Payload divided by response time, expressed in megabytes (MB = 1024*1024 bytes) per second (applies to both Commands and Transactions)
IOPS	Input/Output Operation per Second: Calculated as weighted total of all transactions that overlap with the current one, divided by duration of the current transaction
SDbl - CDbl	Time measured between Submission Doorbell and Completion Doorbell
SDbl - CCmd	Time measured between Submission Doorbell and Completion Command
SCmd - CCmd	Time measured between Submission Command and Completion Command

These definitions are readily available by loading an NVMe Trace, Decoding the NVMe Commands or Transaction, locating the Metrics block in the Trace View and hovering the cursor over each of the NVMe Queue Time Metrics to bring up the Tool Tip.

10.3.3.2 NVME Command Example

As an example for NVMe Command: For SDbl - CDbl see Figure 10.19.

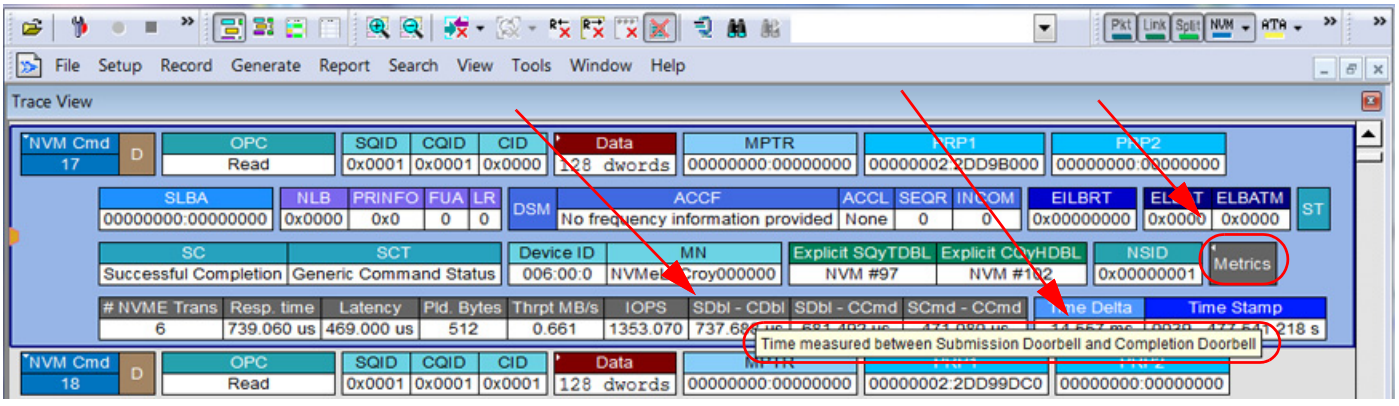


Figure 10.19: NVMe Queue Time Metrics Defined: SDbl - CDbl

10.3.3.3 NVME Transaction Example

As an example for NVMe Transactions: For Resp time: see Figure 10.20.

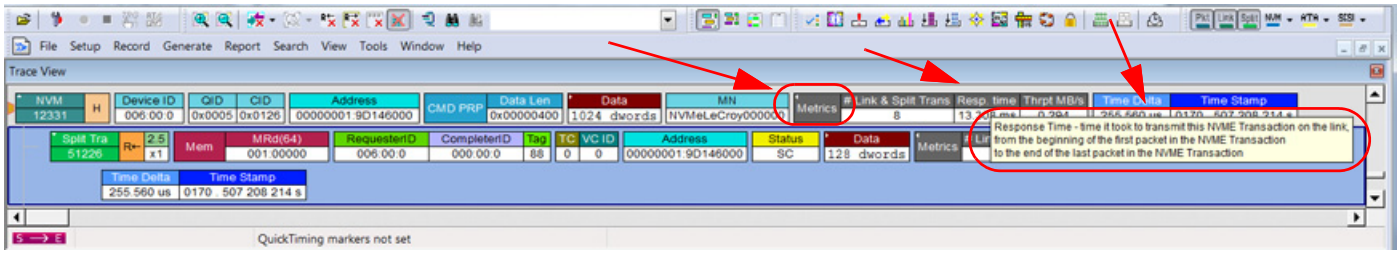


Figure 10.20: NVMe Transactions Metrics: Response Time

10.3.4 Traffic Summary Buttons

Buttons at the top of the Traffic Summary dialog provide options for exporting the data or formatting its appearance:

	Save. Saves Traffic Summary results into an HTML format.
	Email. Attaches an HTML file of the results to a new email.
	Print. Prints results.
	Text. Displays results in HTML format.
	Options. Opens a drop-down menu with the following options: **Grid Lines**: Displays/Hides grid lines **Row Selection**: Allows entire rows to be selected **Tight Columns**: Reformats column widths to match data **Event Navigation**: Skip Hidden Items Show Hidden Items Prompt each time

10.3.5 Traffic Summary for MCTP

After loading an MCTP trace, you can generate a traffic summary report for MCTP Messages (see Figure 10.21), Control Command Code (see Figure 10.22 on page 638) and Control Completion Codes (see Figure 10.23 on page 639).

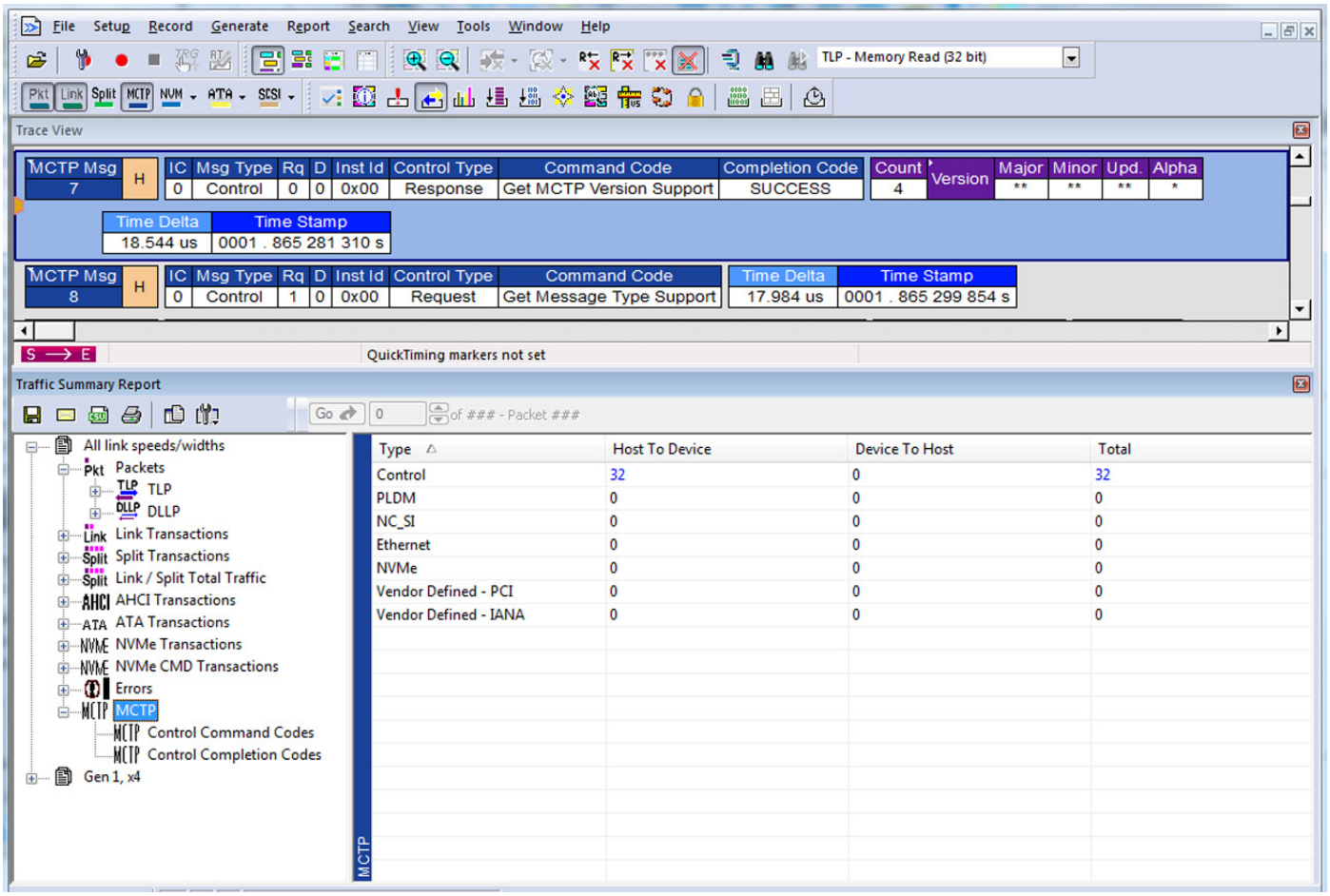


Figure 10.21: MCTP Message Traffic Report Summary -> All

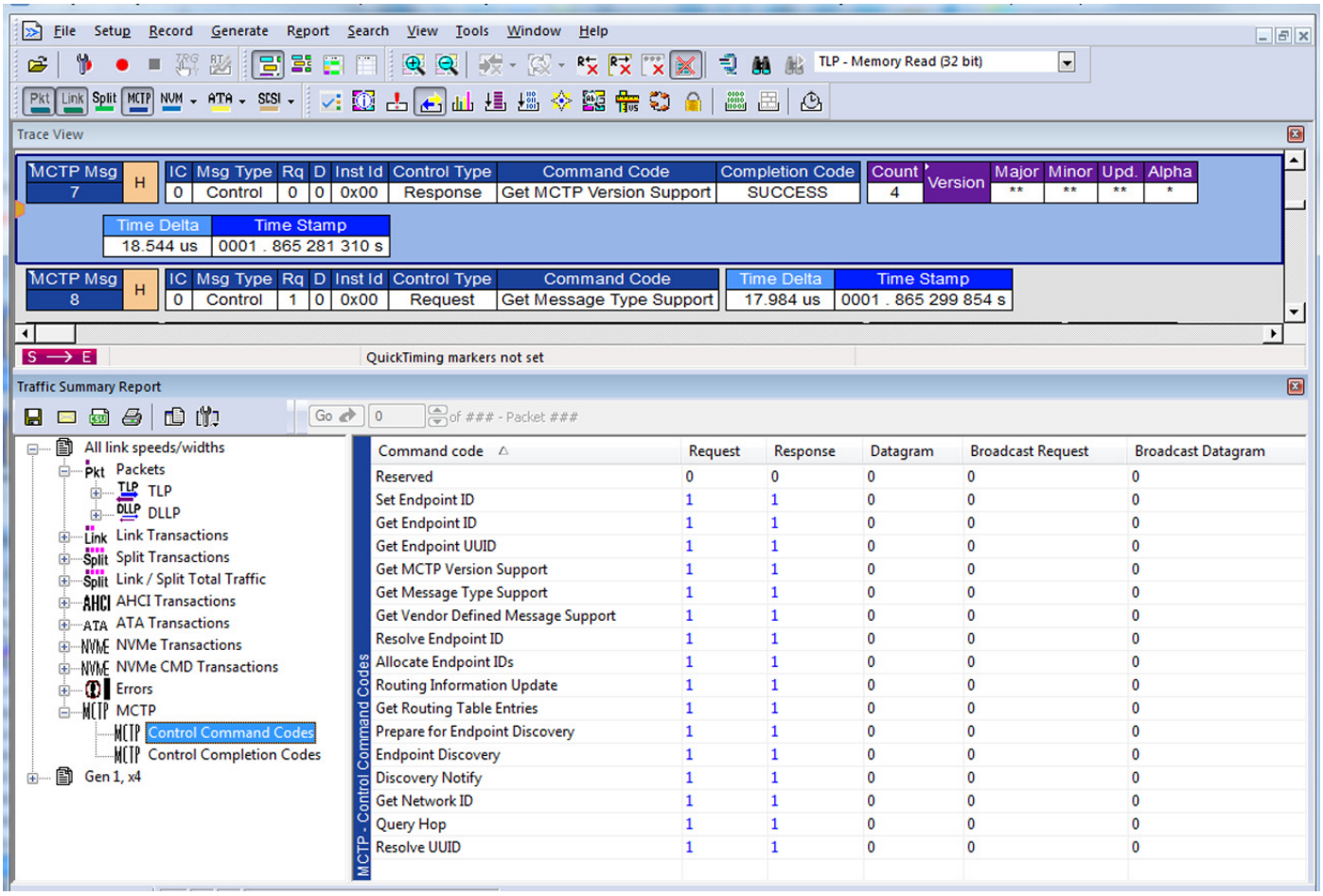


Figure 10.22: MCTP Message Traffic -> Control Command Codes Report

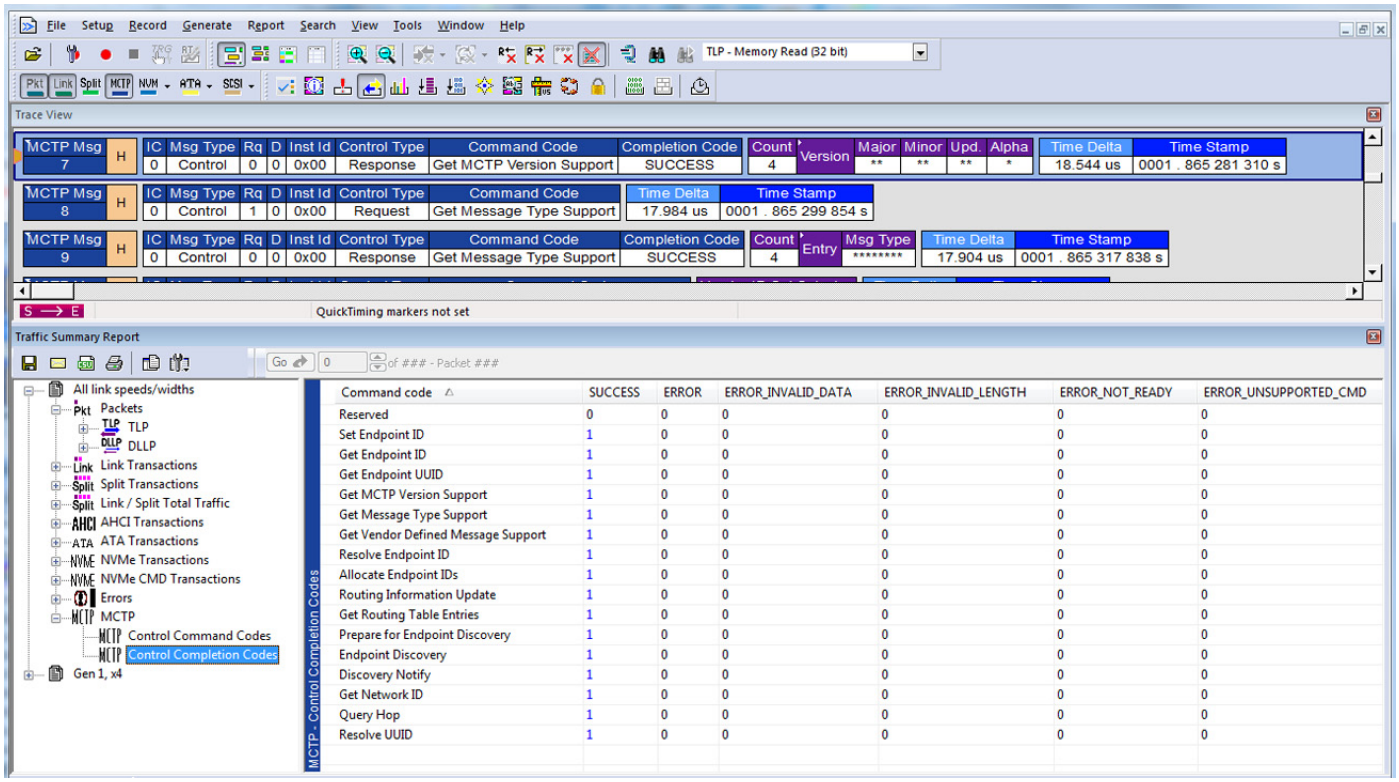


Figure 10.23: MCTP Message Traffic -> Control Completion Codes Report

10.4 Bus Utilization

Select **Report > Bus Utilization** from the menu or press  to open the Bus Utilization dialog.

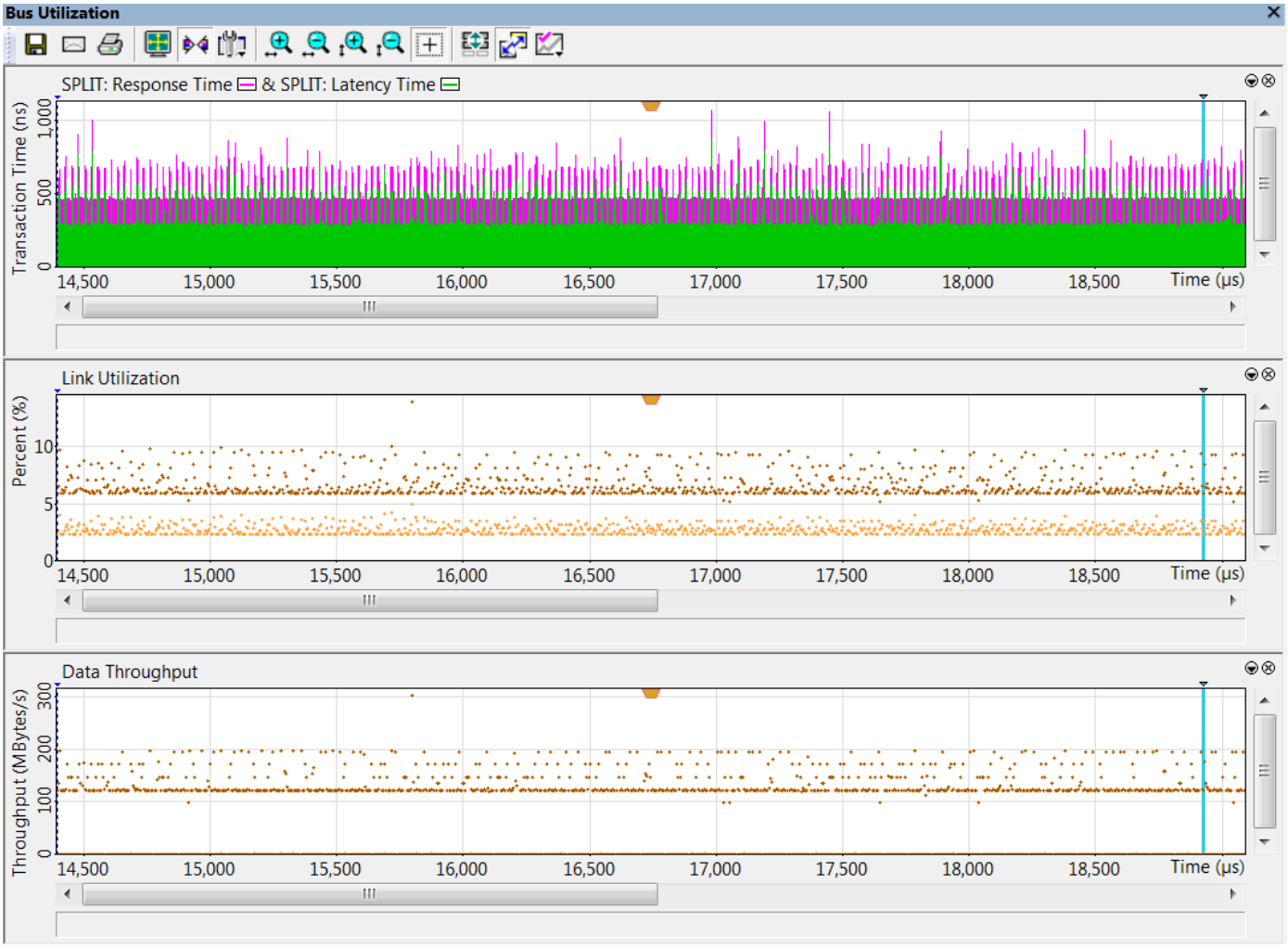


Figure 10.24: Bus Utilization Dialog

The Bus Utilization window displays information on bandwidth use for the transmit and receive channels.

10.4.1 Bus Utilization Pop-up Menu

You can reformat the display by right-clicking a graph and making a selection from the Bus Utilization pop-up menu.

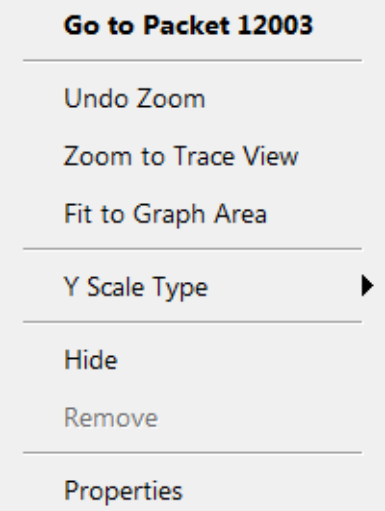


Figure 10.25: Bus Utilization Menu

Go to Packet #: Relocates the CATC Trace to the selected packet number.

Undo Zoom: If you have zoomed in, this command undoes the zoom.

Zoom to Trace View: Zooms in on graph to show traffic currently displayed in the CATC Trace screen.

Fit to Graph Area: Redisplays graph so that the entire CATC Trace fits inside graph area.

Y Scale Type:

- **Linear**: Converts display to linear format
- **Logarithmic**: Converts display to logarithmic format

Hide: Hides the selected graph

Remove: Allows you to add any graph that you created via the **Graph areas**  command.

Properties: Opens a dialog with options for changing the Title, Type, Appearance, Color and Properties of the graphs (see Figure 10.26 on page 642).

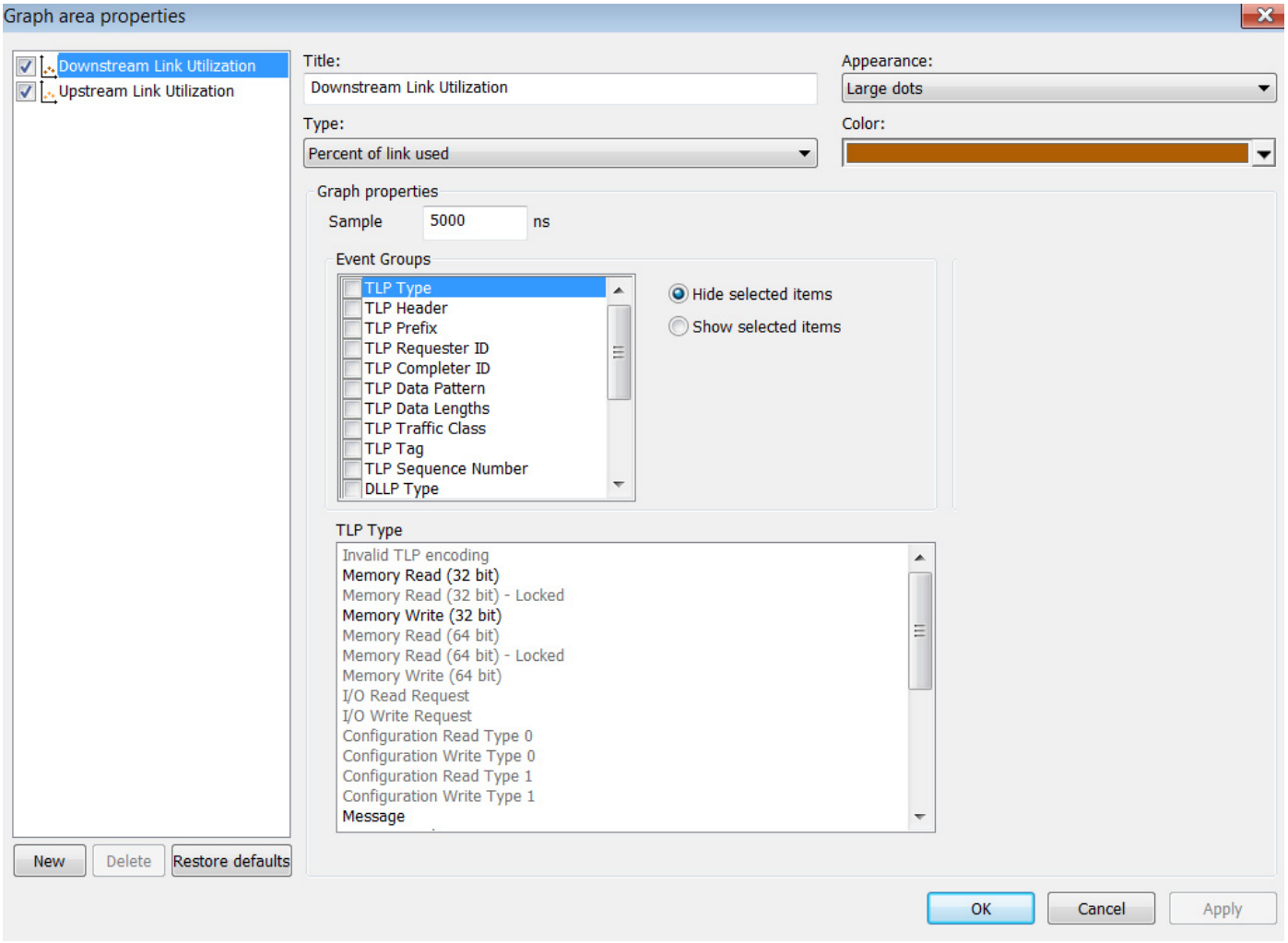


Figure 10.26: Graph Area Properties Dialog

10.4.2 Bus Utilization Buttons

The Bus Utilization window buttons allow you to reformat the display and export data.



Button	Function
	Save. Saves Bus Utilization data to a bitmap file (***.bmp**).

	Email. Opens an email and attaches a bitmap file of the Bus Utilization data.
	Print. Prints the Bus Utilization data.
	Full Screen. Maximizes the Bus Utilization window.
	Synchronize Views.Synchronize the current view with other open views.
	View Settings. Opens a sub-menu with the following choices: •Orient Horizontally •Tile Vertically •Show Markers •Show Plumb Line •Status >> •Bar •Tool tips •None •Grid Lines >> •Both Axes •X Axis •Y Axis •No Grid •Grid on Top •Fonts & Colors
	Horizontal zoom in
	Horizontal zoom out
	Vertical zoom in
	Vertical zoom out
	Click and Drag zoom. Click and drag to zoom in on a part of the graph.
	Select Range. Displays a dialog for selecting a packet range.

	Synchronize Graph Areas. If two or more graphs are displayed, this button synchronizes the graphs to one another. Once synchronized, the positioning slider of one graph moves the other graphs.
	Graph Areas. Provides options for creating and displaying additional graphs of data lengths, packet lengths, and percentage of bus used (see Graph Area Options below).

10.4.2.1 Graph Area Options

The available graphs are shown in Figure 10.27:

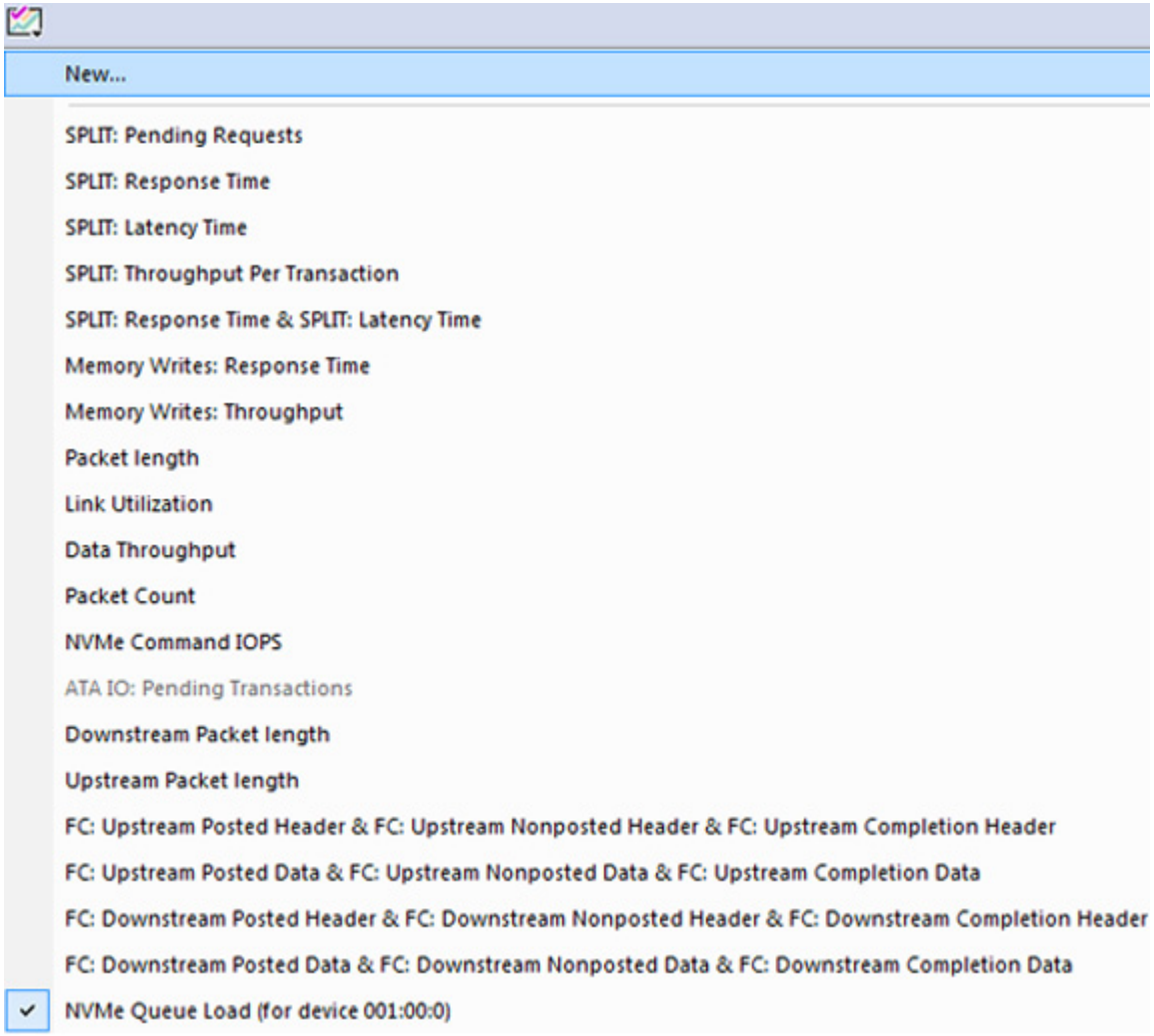


Figure 10.27: Graph Area Options Dialog

- New - Opens Graph Area Properties dialog to specify a new graph
- SPLIT: Pending Requests
- SPLIT: Response Time
- SPLIT: Latency Time
- SPLIT: Throughput Per Transaction
- SPLIT: Response Time & SPLIT: Latency Time

- Memory Writes: Response Time
- Memory Writes: Throughput
- Packet Length
- Link Utilization
- Data Throughput
- Packet Count
- NVMe Command IOPS
- ATA IO: Pending Transactions
- Downstream Packet Length
- Upstream Packet Length
- FC: Upstream Posted Header & FC: Upstream Nonposted Header FC: Upstream Completion Header
- FC: Upstream Posted Data & FC: Upstream Nonposted Data FC: Upstream Completion Data
- FC: Downstream Posted Header & FC: Downstream Nonposted Header FC: Downstream Completion Header
- FC: Downstream Posted Data & FC: Downstream Nonposted Data FC: Downstream Completion Data
- NVMe Queue Load

10.4.2.2 Example: NVMe Queue Load Graph Feature

This enhancement adds new Bus Utilization graph that indicates how many NVMe queue slots are occupied through the trace. There are separate graphs for each device, present in a trace, each queue is represented by a line. User can select queues to show. See Figure 10.28.

This graph can only be built after the NVMe level is decoded. Trace has to contain doorbells and submission/completion queues. If any of these conditions is not fulfilled, "Graph Areas" popup menu will have "NVMe Queue Load" item disabled. If required transactions are filtered out (for instance, using NVMe Enhanced Mode), user will be additionally prompted in popup menu entry.

Note: If trace with the graph is re-opened with persistent decoding disabled, empty graph area will be shown. After NVMe level decoding graph area gets deselected. Showing graph right after required levels are decoded should be considered as enhancement.



Figure 10.28: Bus Utilization: NVMe Queue Load

10.4.2.3 Graph Legend

Graph legend can be viewed by moving mouse pointer over graph title. See Figure 10.29 on page 647.

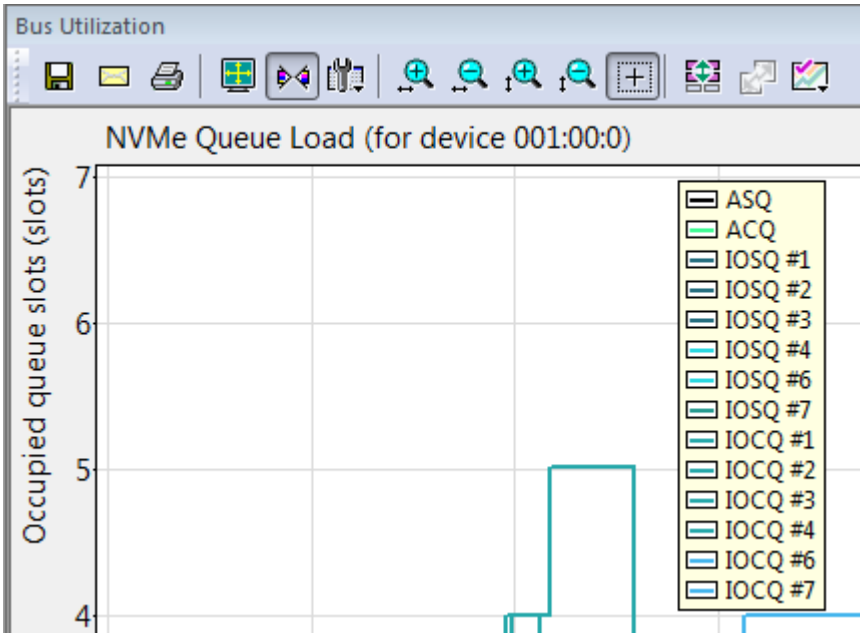


Figure 10.29: Bus Utilization: Graph Legend Details

10.4.2.4 Graph Properties

Queues to show can be selected in Graph Properties (as well as line colors). See Figure 10.30.

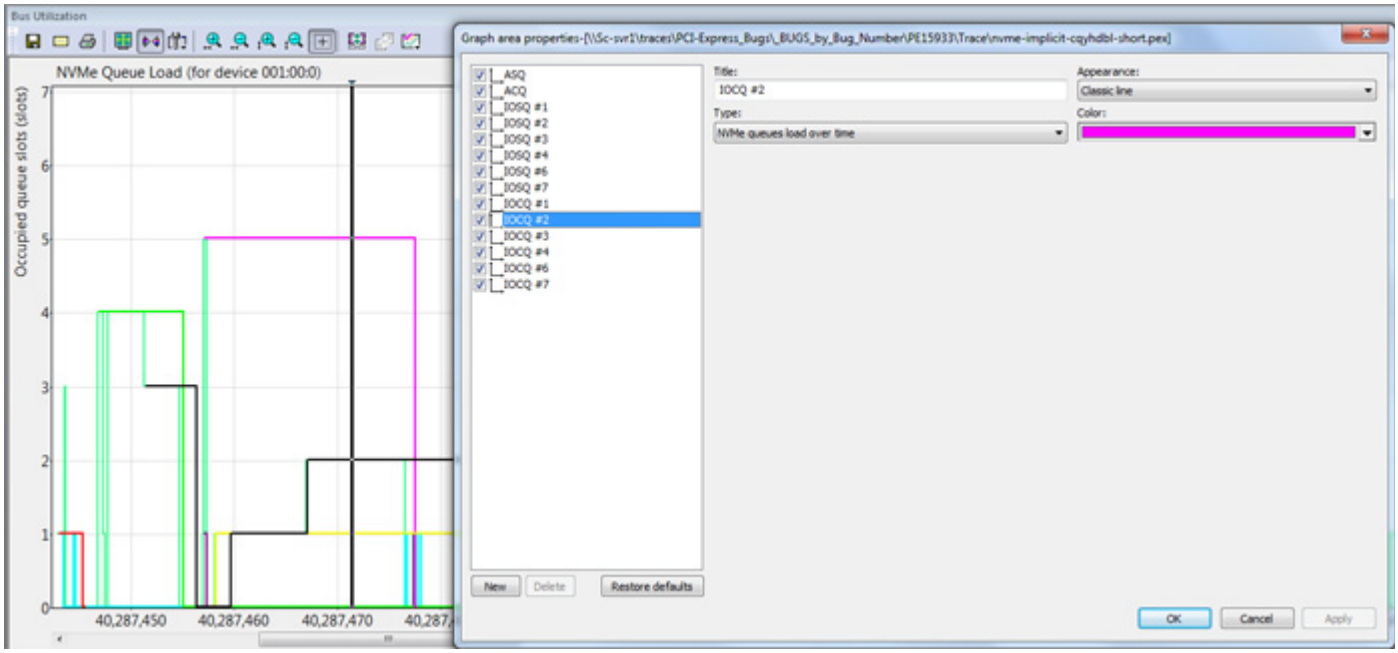


Figure 10.30: Bus Utilization: NVMe Queues => Selected in Graph Properties

10.5 Link Tracker

Open the Link Tracker window by selecting the Link Tracker Icon (to the right of the Bus Utilization Icon in the main toolbar) .

The Link Tracker window displays a detailed chronological view of events. Events are shown on a channel-by-channel basis in columns within the window.

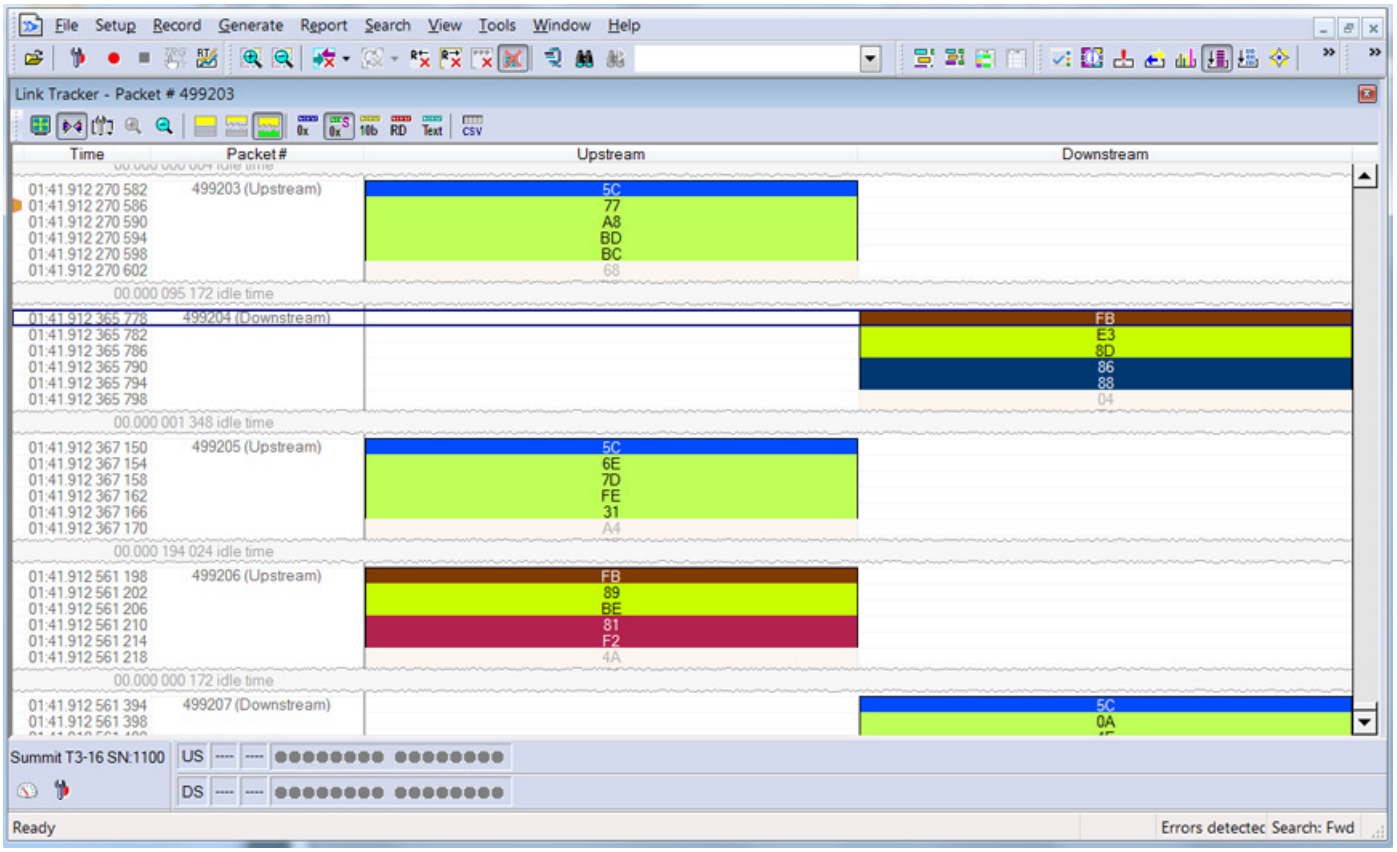


Figure 10.31: Link Tracker Window

Each time slot in the vertical axis represents the minimum time that a DWORD requires to traverse the bus.

Toolbar: Presents buttons for changing the format of the Link Tracker window.

Main Display Area: Displays traffic chronologically as it occurred in the recording. The window divides into columns: the first column shows time and traffic is shown on a channel-by-channel basis in the columns on the right.

10.5.1 Using the Link Tracker Window

The Link Tracker window can be reformatted in several ways.

10.5.2 Zooming In and Out

Zooming out can give you a quick, high-level view of a CATC Trace. A fully zoomed out CATC Trace only shows columns and colored lines. Using the colors, you can see what types of traffic run through the CATC Trace.

Further information can be obtained on any point of interest in the CATC Trace by positioning your mouse pointer over it. Tool tips provide detailed description of events.

When fully zoomed out, the smallest graphical unit is the DWORD, represented by a single line. Zooming out makes the CATC Trace appear smaller and increases the time scale in the first column.

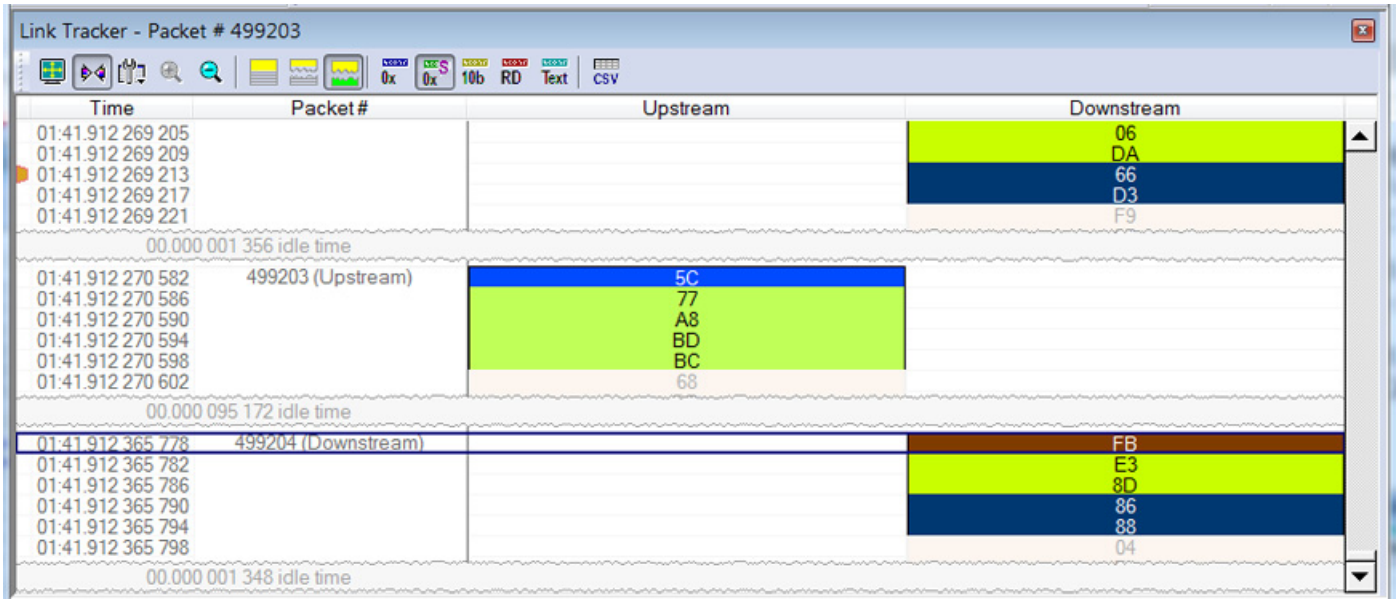


Figure 10.32: Link Tracker: Zoomed Out

10.5.3 Collapsing Idle Time, Enabling Tool tips, and Resetting Column Widths

Click the **View Options** button  to open a menu with options for formatting the display. Three options are presented:

Collapsible Idle Time: Opens a dialog box for setting the Idle time value. Setting a value tells the Analyzer when to collapse Idle times and display them as grayed out strips within the Bus View window.

Tooltip Display: Opens a menu with options for adding content to Tooltips. Tooltips display when you position the mouse pointer over an item in the Bus View window. The options are:

- Tooltips Display Values
- Tooltips Display Scrambled Values
- Tooltips Display 10-bit Codes
- Tooltips Display Symbols

Time Format: Seconds or Clock

Reset Column Widths: This option resets column widths to their defaults and enables columns to resize themselves automatically any time the application window is resized. Normally, columns automatically resize themselves if the application window is made larger or smaller. However, if you manually resize any columns in the Bus View window, column widths become static. Thereafter, if you resize the application window, the Bus View columns do not adjust automatically. Reset Column Widths re-enables the automatic resizing capability.

Reset Columns Order: Return to default column sequence.

10.5.4 Docking and Undocking the Window

You can undock the Link Tracker window by double-clicking the blue title bar along the left side of the window. Once undocked, the window can be dragged anywhere in the application. To re-dock double-click again on the title bar.

10.5.5 Setting Markers

Markers can be set on any event within the Link Tracker window.

To set a marker, right-click an event, then select **Set Marker** from the pop-up menu.

Once marked, you can navigate to events with the **Go to Marker** command in the Search menu.

Markers set in the Link Tracker window display the packet number and DWORD number. In contrast, markers set in the CATC Trace window just show the packet number.

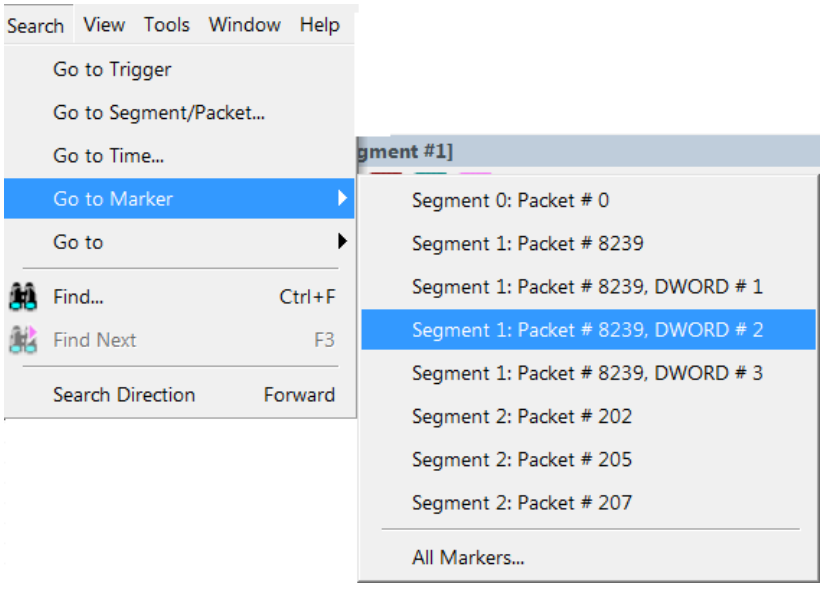


Figure 10.33: Selecting the Go to Marker Option

10.5.6 Calculating Time between DWORDs

You can calculate time between DWORDs by clicking an event and then positioning your mouse pointer over a second event and reading the ensuing Tool tip.

Click the **time value** for the first event. Scroll down through the CATC Trace to the second event and position the mouse pointer above its time value. A Tool tip appears showing the time interval between the first and second events.

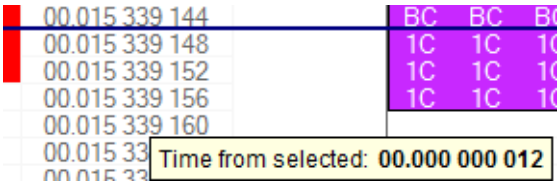


Figure 10.34: Viewing Time Values

10.5.7 Hiding Traffic

You can hide Idles and other data from the Link Tracker window by clicking the **Hide** buttons on the toolbar.

10.5.8 Link Tracker Buttons

The Link Tracker window has a row of buttons for changing the format of the displayed data and for exporting data: The buttons have the following functions:

	Full Screen. Expands the Link Tracker window to fill the entire screen.
	Synchronize Trace View. Synchronizes the Trace View and Link Tracker windows so that a move in one window repositions the other. Because of the differences in scale and logic between the Link Tracker and Trace view window, scrolling produces different effects depending on which window is being scrolled. Scrolling in the CATC Trace window causes the Link Tracker window to rapidly jump from event to event. Long periods of idle time are thus skipped. Scrolling in the Link Tracker window, in contrast, produces modest movements within the CATC Trace window. Scrolling in the Link Tracker window causes the CATC Trace window to pause until the beginning of a packet is displayed. At that point, the CATC Trace window repositions itself. While scrolling long Idle periods or through the contents of a packet, the CATC Trace window does not move.

	View Options. Opens a menu with three options: •**Collapsible Idle Time** (Collapse Idle Bigger Than **n** nanoseconds. **Note:** Does not affect Collapse Idle Plus.) •**Tooltip Display** (Values, Scrambled Values, 10-bit Codes, Symbols) •**Time Format** (Seconds, Clock) •**Reset Columns Widths** (return to default widths) •**Reset Columns Order** (return to default column sequence) See "Using the Link Tracker Window" on page 648 for further details.
	Zoom In
	Zoom Out
	Continuous Time Scale. No collapsing.
	Collapse Idle. Do not show some periods of Link being idle.
	Collapse Idle Plus. Do not show periods of Link being idle.
	Show Descrambled Bytes
	Show Scrambled Bytes
	Show 10b Codes
	Show Symbols
	Show Text
	Show Binary values
	Export to CSV file

10.5.8.1 Exporting to CSV File

To export trace file information to a CSV file, select the variables you want in the file and select the CSV Icon. A window with your variables will pop up that also shows you the file name and path. See Figure 10.35.

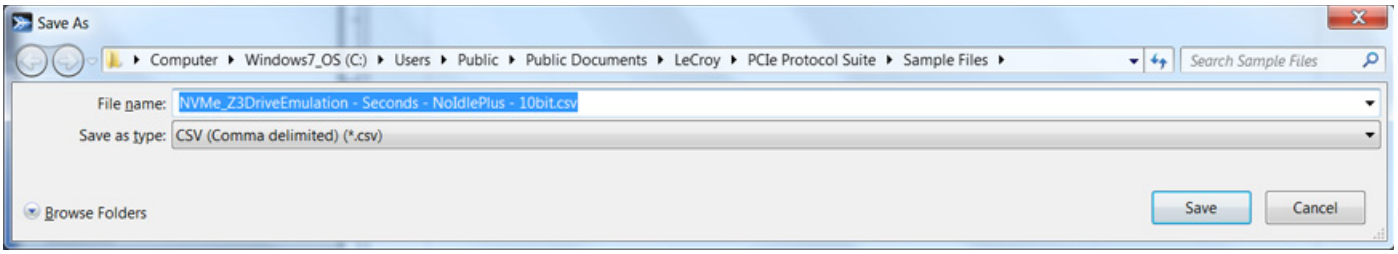


Figure 10.35: Link Tracker: CSV File to be Saved and Location

Select Save and the tool will start. See Figure 10.36.

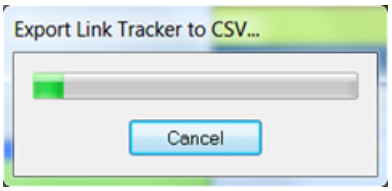


Figure 10.36: Tool Exporting Link Tracker Data to CSV File

The generated CSV file can be viewed in Excel.

10.6 Data Flow Window

The Data Flow window shows marker, packet, direction, type, length, address, payload, handshake, and timestamp information.

To obtain the Data Flow window, select **Report > Data Flow**

or click the  Data Flow toolbar icon.

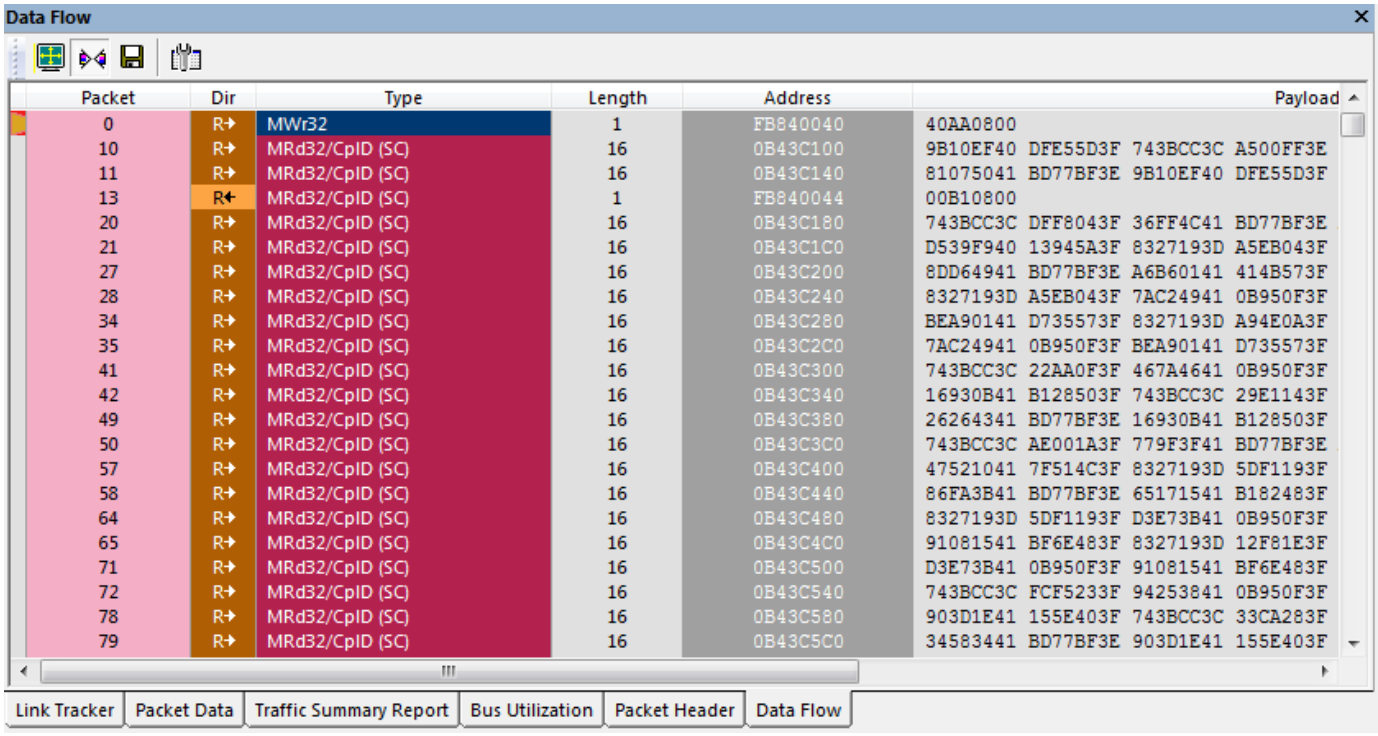


Figure 10.37: Data Flow Window



The toolbar allows you to (see Figure 10.38 on page 655):

- Expand the window to full screen or Collapse to a smaller window.
- Synchronize.
- Save.
- Select Data Flow columns to display and their widths:
  - Marker
  - Packet
  - Direction
  - Type
  - Length
  - Address
  - Payload
  - Handshake
  - Time Stamp

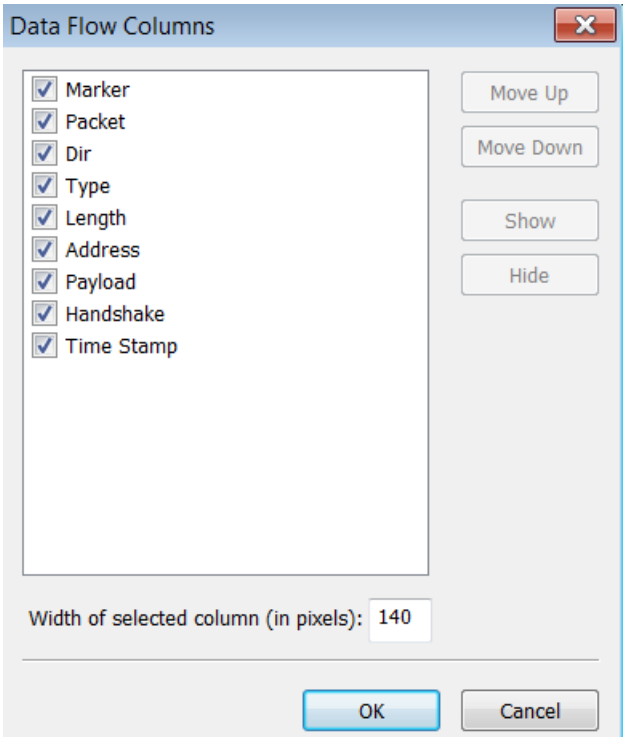


Figure 10.38: Data Flow Columns Dialog

10.7 Flow Control Tracking

The Flow Control View mode highlights portions of the packets that affect flow control and displays flow control values. Flow control values shown at the beginning of Link Transaction display the credit values that were available prior to TLP transmission. Flow control values shown at the end of the Link Transaction display the credit values that were available after TLP was transmitted. Hover the mouse over the field to display tool-tips. Refer to the following screen capture.

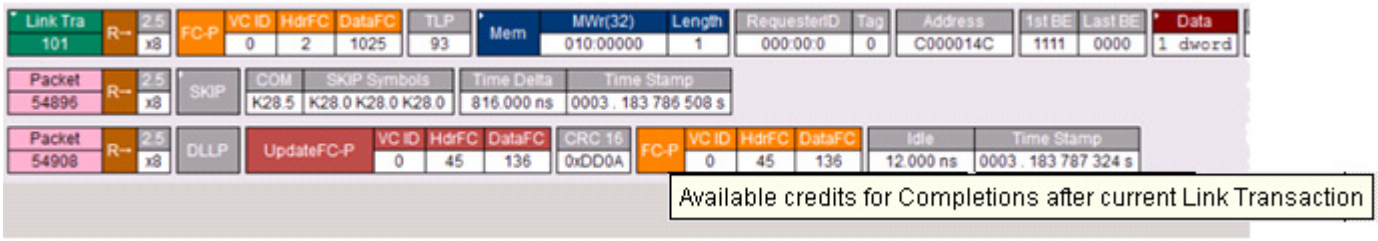


Figure 10.39: Flow Control Display

If the trace includes Flow Control initialization, PCIe Protocol Analysis detects the amount of available credits based on the values advertised in InitFC packets. If the InitFC packets are not in the trace, the amount of available credits can be set using the FC Credit Setup dialog. Select **View > FC Credits Setup...** displays the FC Credit Setup dialog (see the following screen capture).

For each virtual channel that is present in the trace you need to specify the amount of available credits before the beginning of the trace. You can also specify the values of credit fields for UpdateFC packets before the beginning of the trace. If the values of the UpdateFC credit fields are

different than the values in the first UpdateFC packet, Flow Control tracking view will show that the first UpdateFC packet is releasing appropriate amount of credits. By default, PCIe Protocol Analysis sets these values to match the first UpdateFC packets in the trace.

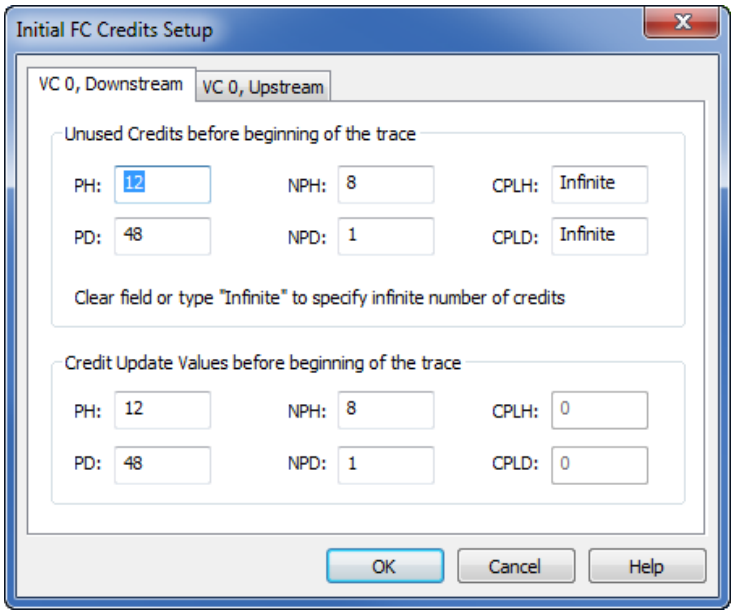


Figure 10.40: Flow Control Setup Dialog

10.8 Using the CATC Trace Navigator

The CATC Trace Navigator is a tool for navigating within the CATC Trace. It allows you to view the location of errors and triggers in a CATC Trace and to narrow the range of traffic on display. It also allows you to quickly jump to any point in the CATC Trace.

10.8.1 Displaying the Navigator

Click  in the toolbar to display the Navigator. The Navigator appears on the right side of the Main window. It has a two-button toolbar and a vertical slider bar. It also has colored panes for navigating the CATC Trace in different ways. You set which panes are displayed through Navigator pop-up menus (see Figure 10.41 on page 657).

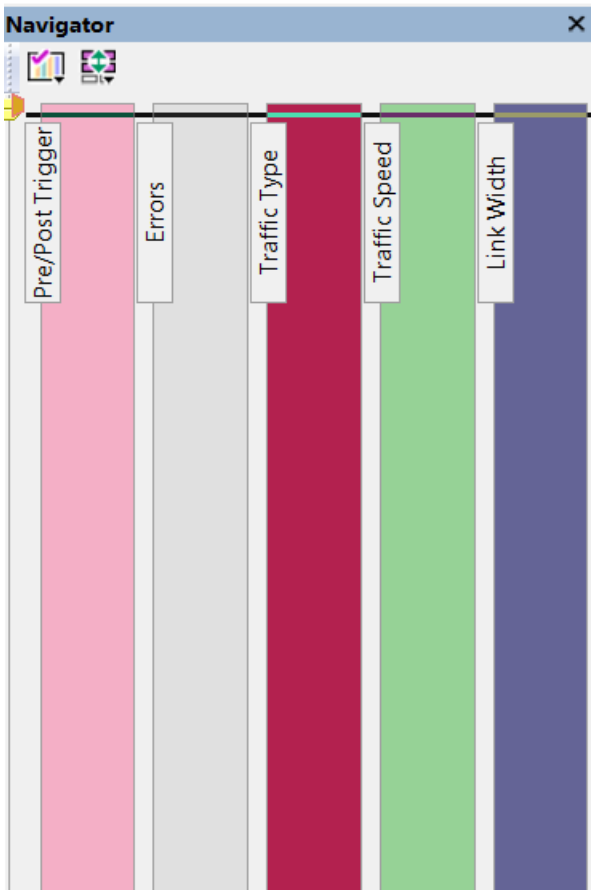


Figure 10.41: Navigator Dialog

10.8.2 Navigator Toolbar

The Navigator toolbar lets you quickly set Navigator features. The toolbar has two buttons.





Navigator Ranges: This button brings up a pop-up menu that lets you reset the Navigator range. The range determines what packets are viewable in the CATC Trace display.



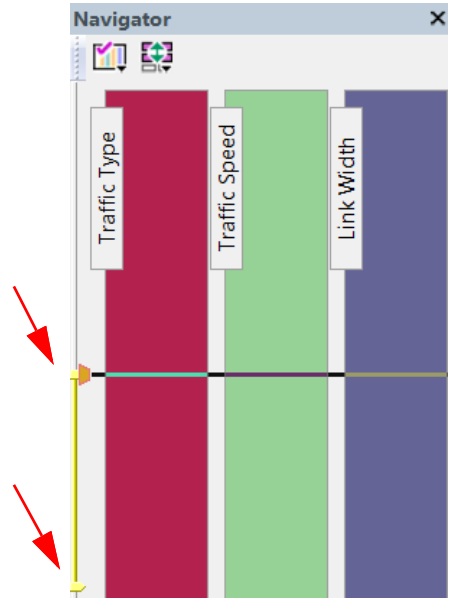
Navigator Panes: This button has two purposes: To select which Navigator panes appear and to bring up the Navigator legend. The legend determines how information is shown in the panes.

10.8.3 Navigator Ranges

You set the viewing range by dragging the **yellow range delimiters** along the slider. To set the lowest packet viewable, drag the **top delimiter up**. As you do so, a tool tip appears to indicate the current range. Stop dragging when you reach the desired lowest packet.

To set the highest packet viewable, drag the **bottom delimiter down**. Stop when the tool tip indicates you are at the desired highest packet.

.



10.8.4 To Determine Current Position

In addition to the two range delimiters, the slider has a **blue current-position** indicator (see above). The current-position indicator shows where you are in the CATC Trace display with respect to the possible viewing range.

For example, suppose you set viewing range to packet 0 through packet 500 (the top range delimiter is at packet 0, and the bottom range delimiter is at packet 500). If you then move the current-position indicator on the slider to midway between the top and bottom delimiters, then packet 250 appears in the middle of the CATC Trace display.

10.8.5 To Reset Navigator Range

You can reset the Navigator range using the toolbar **Navigator Range** button. Press the button to bring up the Navigator Range drop-down menu.

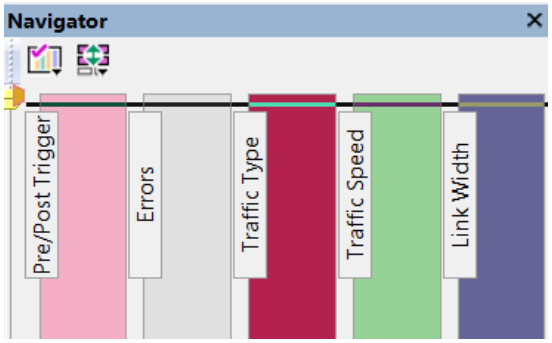


The menu has the following options:

- **Set Range to Whole Trace**: Allows you to reset the range to include the entire CATC Trace file contents. The top range delimiter is placed at the lowest packet number in the CATC Trace. The bottom range delimiter is placed at the highest packet number in the CATC Trace.
- **Set Range Near Packet xxx**: Allows you to collapse the range so that only the packets immediately above and below the xxx packet are displayed. The xxx packet is whatever packet is currently at the top in the CATC Trace display.
- **Recently Used Ranges**: Allows you to reset the range to any of a number of recently used (previously set) ranges.

10.8.6 Navigator Panes

You can display any combination of CATC Trace Navigator panes.



From left to right, the panes are: Pre/Post Trigger, Errors, Traffic Type, Traffic Speed, and Link Width. Each pane represents the entire CATC Trace with respect to different types of information. The top of each pane represents the start of the CATC Trace file, and the bottom represents the end of the CATC Trace file.

- **Pre/Post Trigger:** To view the trigger event in the CATC Trace and the relative size of pre-trigger and post-trigger portions of the CATC Trace. The two portions are set apart as different colors. The trigger event occurs at the point the two colors meet.
- **Errors:** To view any errors in the CATC Trace. A thin red line represents each error in the pane.
- **Traffic Type:** To view the types of packets that occur in the CATC Trace. A different color represents each packet type in the pane. The relative size of colored portions in the pane corresponds to the amounts of the various packet types in the CATC Trace. As described below, you can use the Navigator legend to change the types of packets that take precedence in the display.
- **Traffic Speed:** To view the speed that occurs in the CATC Trace.
- **Link Width:** To view the link width that occurs in the CATC Trace.

10.8.7 To Show/Hide Nav55igator Panes

You can show/hide any of the panes using pop-up menus accessible through left-click the **Navigator Panes** button or by right-click anywhere in any CATC Trace Navigator pane.

10.8.8 Navigator Slider

The Navigator slider appears at the left of Navigator panes. The slider has **yellow upper and lower range delimiters** and a **blue current-position** indicator.

The Navigator slider lets you to set the range of packets viewable in the CATC Trace display. In other words, it sets scrolling range of the display. You can scroll the display up to the lowest packet number in the viewing range. You can scroll the display down to the highest packet number in the viewing range.

10.8.9 CATC Trace Navigator Legend

The Navigator legend lets you control the display of content in Navigator panes.

You bring up the legend through the Navigator Pane's drop-down menu. Press the toolbar **Navigator Panes** button to access the menu. Select the **Legend** option to bring up the Navigator Legend dialog (see Figure 10.41 on page 657).

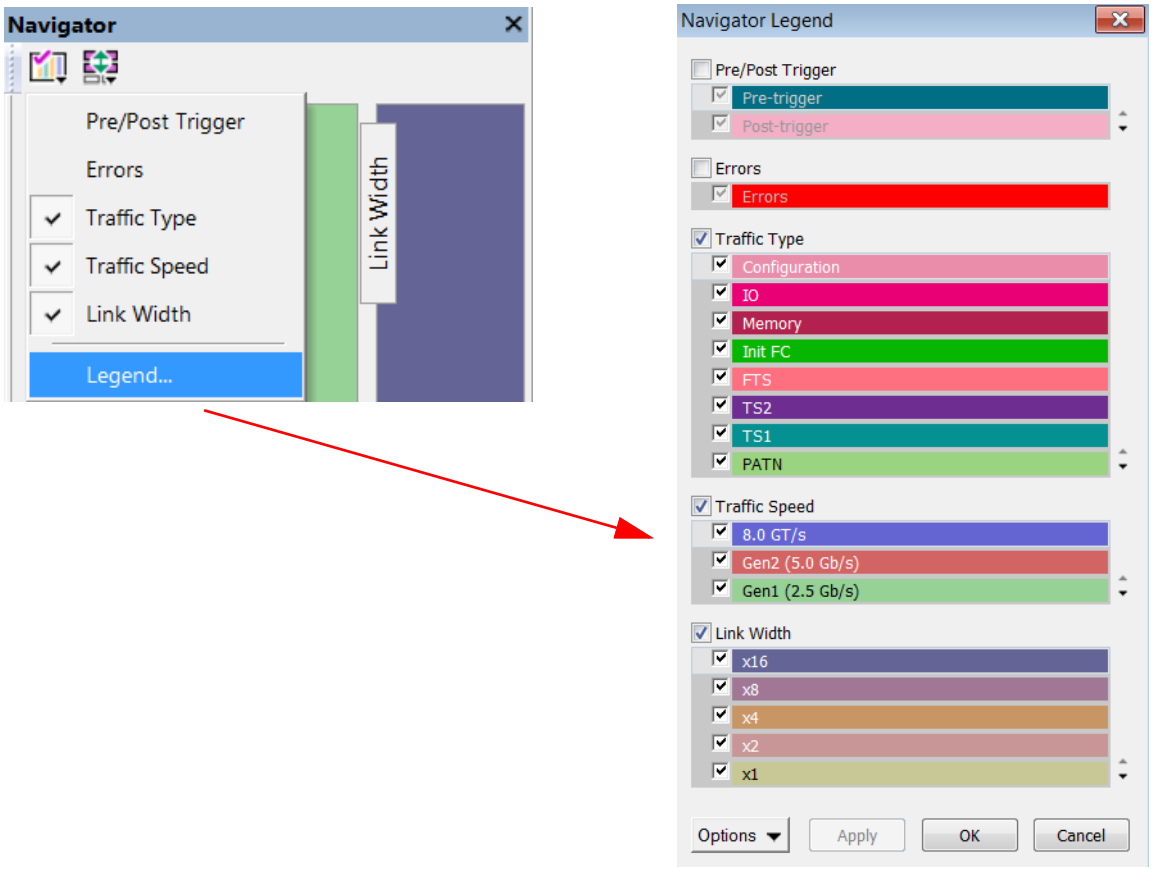


Figure 10.42: Navigator Pane and Navigator Legend Dialog

The Navigator Legend dialog has areas corresponding to each of the panes. Each area has check boxes that allow you to hide/display information in the pane. You can set the priority of information displayed in the panes using the up and down triangles on the right.

10.8.10 Using the Legend to Show/Hide Navigator Panes

To use the legend to show/hide an entire pane, use the **checkbox** next to the name of each pane in the legend.

In the case of the Pre/Post Trigger and Errors areas, the action of show/hide in the legend is identical to that provided by CATC Trace Navigator pop-up menus.

In the case of the Traffic Types pane, there is no equivalent show/hide available through the pop-up menus.

10.8.11 Using the Legend to Set the Priority of Information Display

You can use the legend to set the priority of information displayed in the Pre/Post Trigger Traffic Type panes. This is a two-step process.

1. For a particular item in a pane, click the **column next to the checkbox** for the item. That labels the item as currently active.
2. Next, use the **up-down** at the lower-right of the area to move the item higher or lower in priority.

In the case of the Traffic Type pane, priority determines display priority of each packet type. For portions of the CATC Trace that are dominated by a particular packet type, this setting no effect: only the color corresponding to that packet type is displayed in that portion of the pane. Suppose, however, that part of the CATC Trace includes equal or near equal numbers of several types of packets. In that case, you can use the legend to select which among those types is represented in that portion of the Traffic Types pane. This allows you to view only packets of interest in crowded portions of the CATC Trace display.

10.9 Detail View

Click  to show the Detail View of the selected packet.

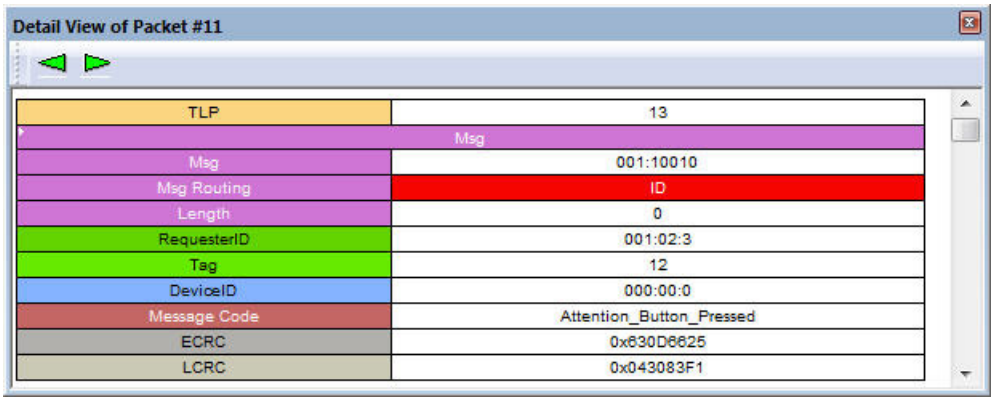


Figure 10.43: Detail View

10.10 LTSSM Flow Graph

The LTSSM Flow Graph shows link state transitions that the link goes through, as recorded in the CATC Trace file.

To obtain the LTSSM Flow Graph (see Figure 10.44 on page 663), select **Report > LTSSM Flow Graph.**

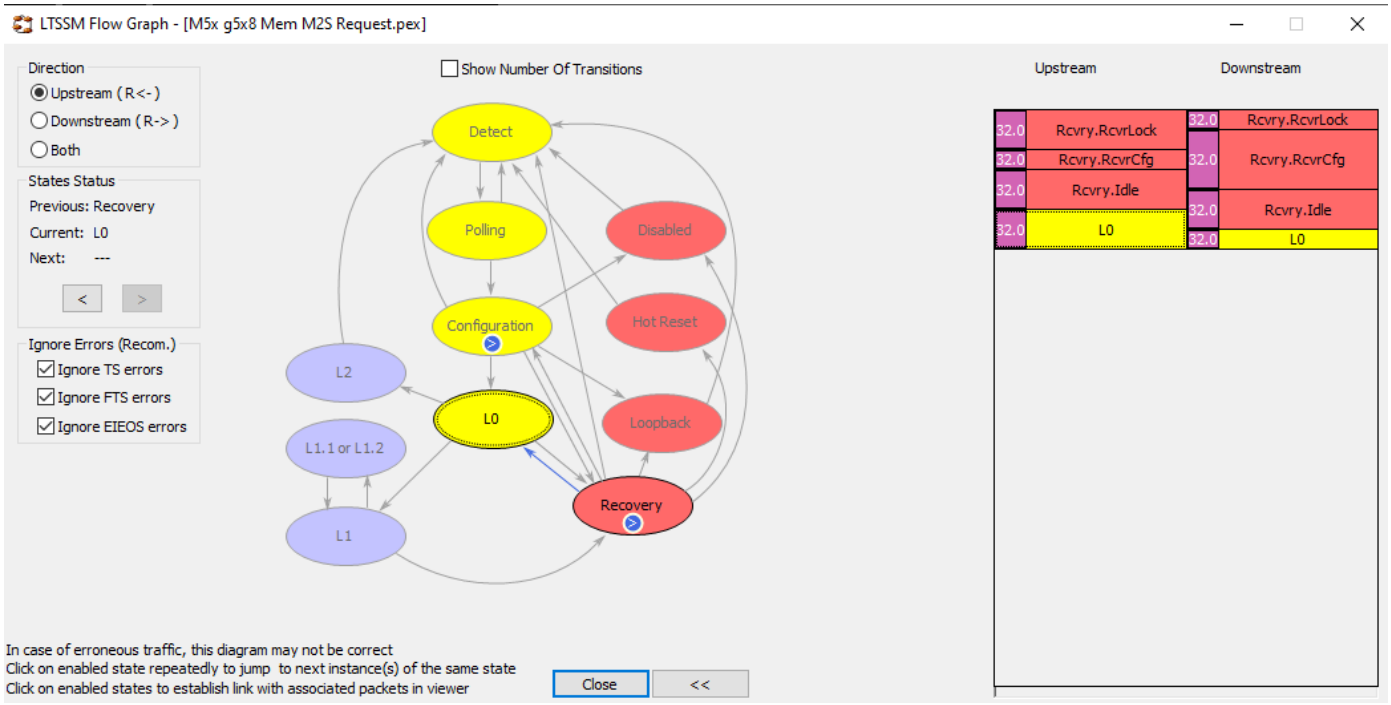


Figure 10.44: LTSSM Flow Graph Dialog

You can enable or disable ignoring of TS/FTS/EIEOS packets with errors so they will not affect the diagram if enabled.

You can display the following directions:

- Upstream
- Downstream
- Both

You can also **Show Number of Transitions**.

10.10.1 LTSSM Dynamic Equalization

You can review the PreCursor, Cursor and PostCursor values that the analyzer has used during the dynamic equalization phase of the LTSSM process by selecting the LTSSM icon on the toolbar and checking the following steps: See Figure 10.45.

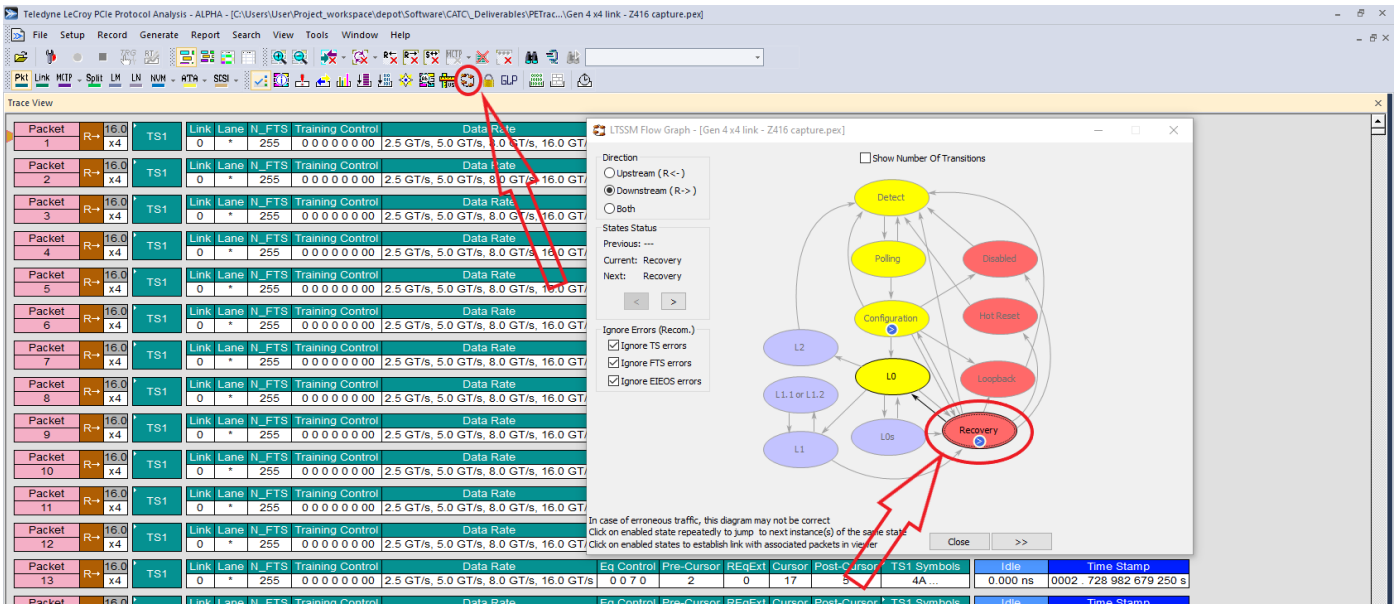


Figure 10.45: Recovery Phase of LTSSM

Click on the arrow in the blue circle in the Recovery state to see more detail. See Figure 10.46 on page 665.

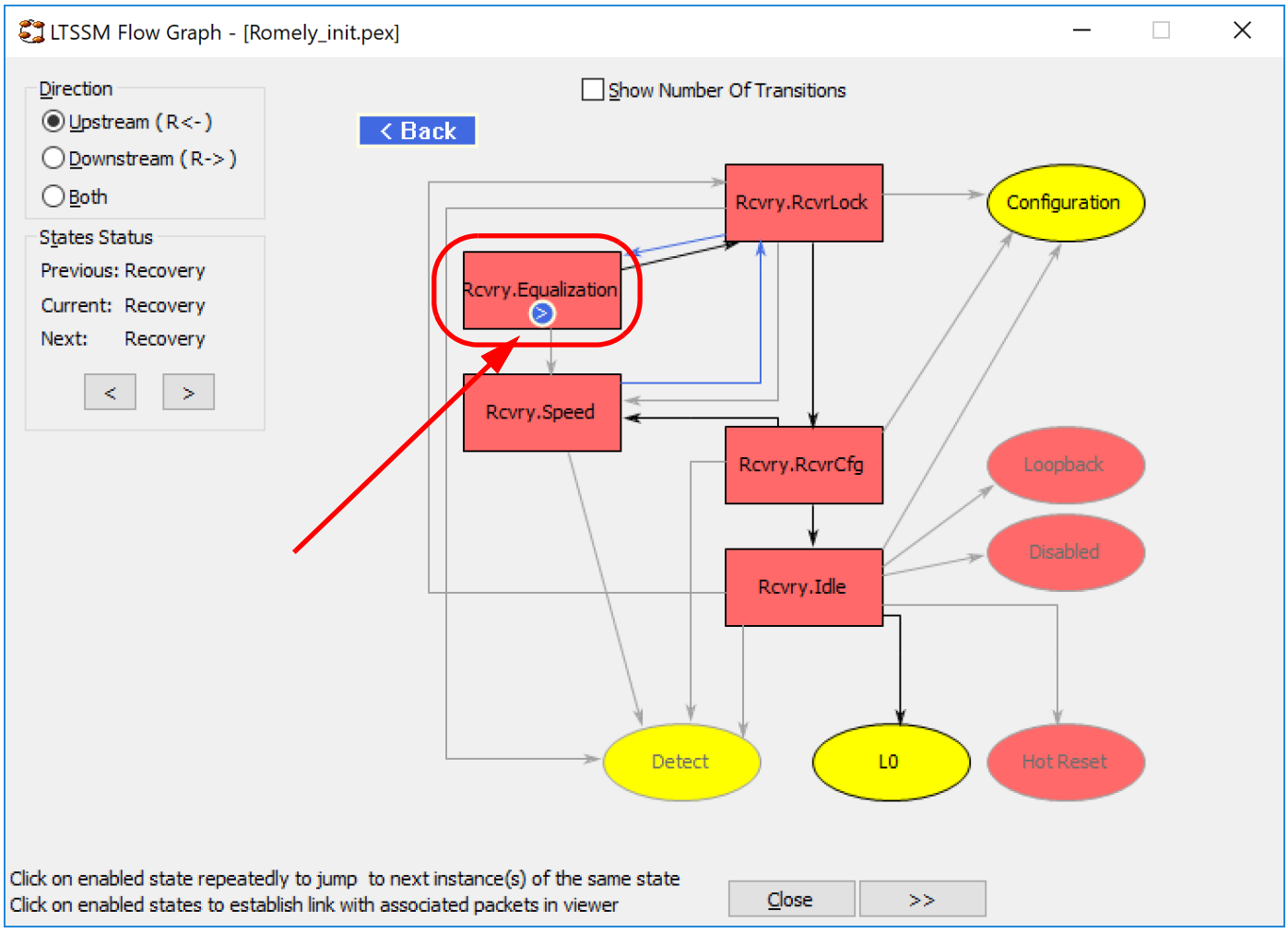


Figure 10.46: Recovery Equalization State

Click on the blue circle with the white arrow in the Recovery.Equalization state to review the PreCursor, Cursor and PostCursor values. See Figure 10.47 on page 666.

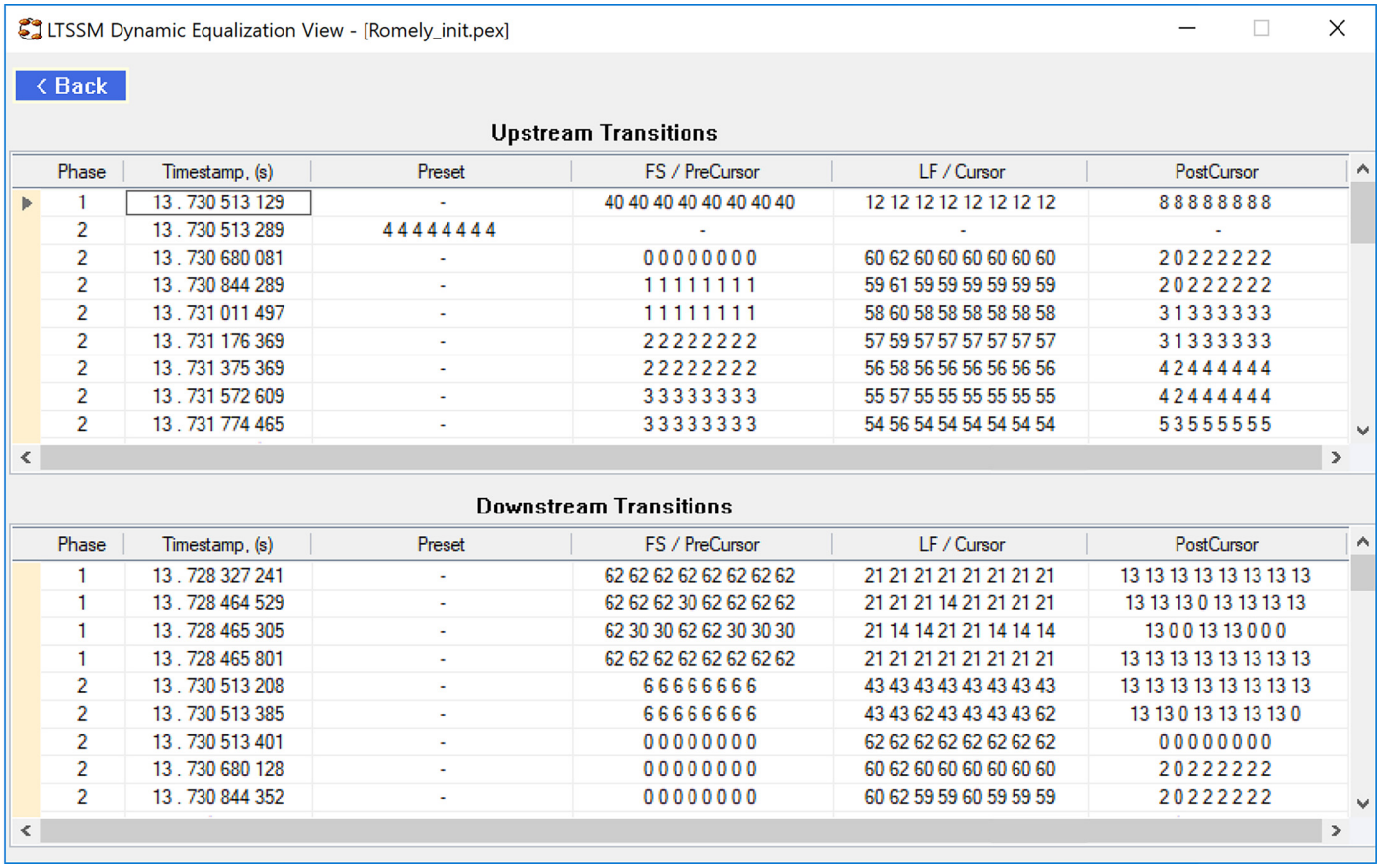


Figure 10.47: LTSSM Dynamic Equalization: PreCursor, Cursor and PostCursor Values

10.11 Packet Header Bar

The Packet Header bar shows packet header information.

To display the Packet Header bar (see Figure 10.48 on page 667), select **Report > Packet Header** or click the toolbar icon.

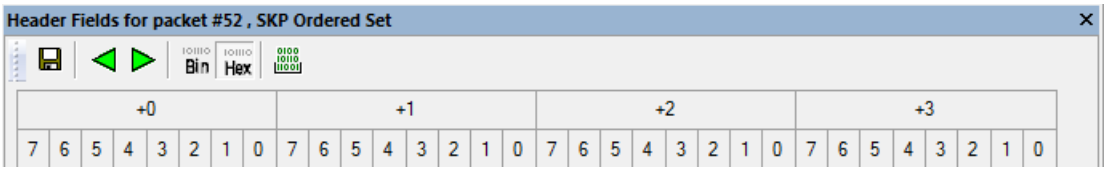


Figure 10.48: Packet Header Bar

The toolbar allows you to Save, go to Previous or Next, display Hexadecimal or Binary, and show the Packet Data window.



10.12 Packet Data Window

The Packet Data window shows packet or transaction payload.

To display the Packet Data window, select **Report > Packet Data** or click the toolbar icon.

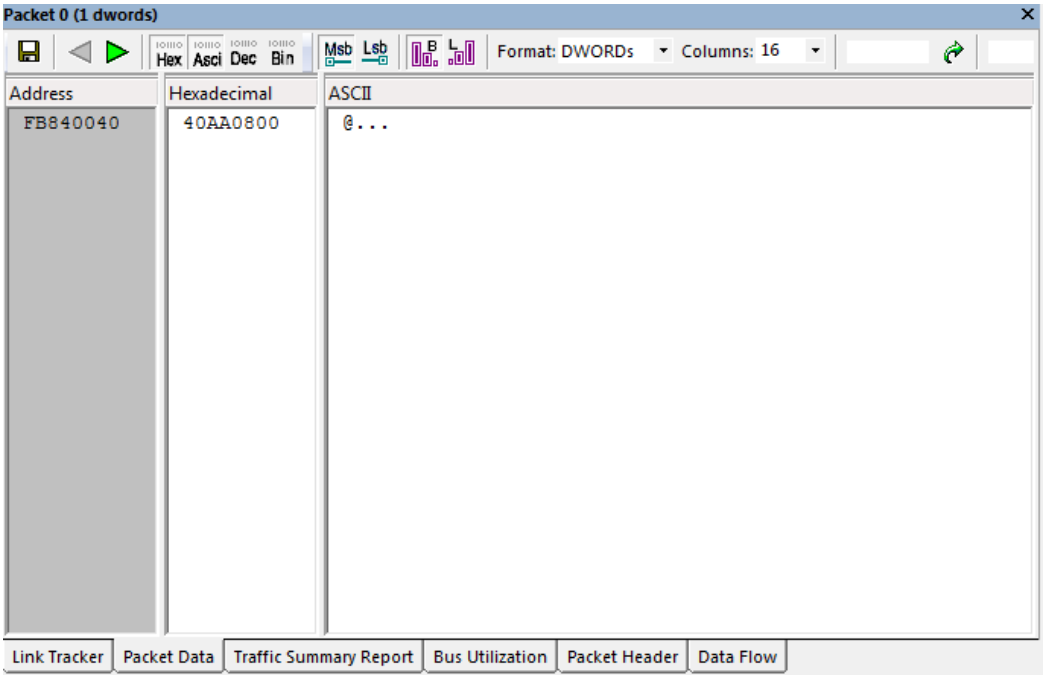
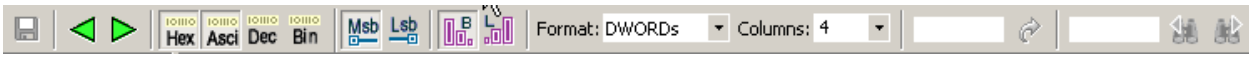


Figure 10.49: Packet Data Window

The toolbar allows you to Save; go to Previous or Next; display Hexadecimal, ASCII, Decimal, or Binary; use MSB Format or LSB Format; and use Big Endian or Little Endian.



Format and Columns allows you to enter the number of bytes, words, or dwords per line.

You can enter an Offset and scroll to it.

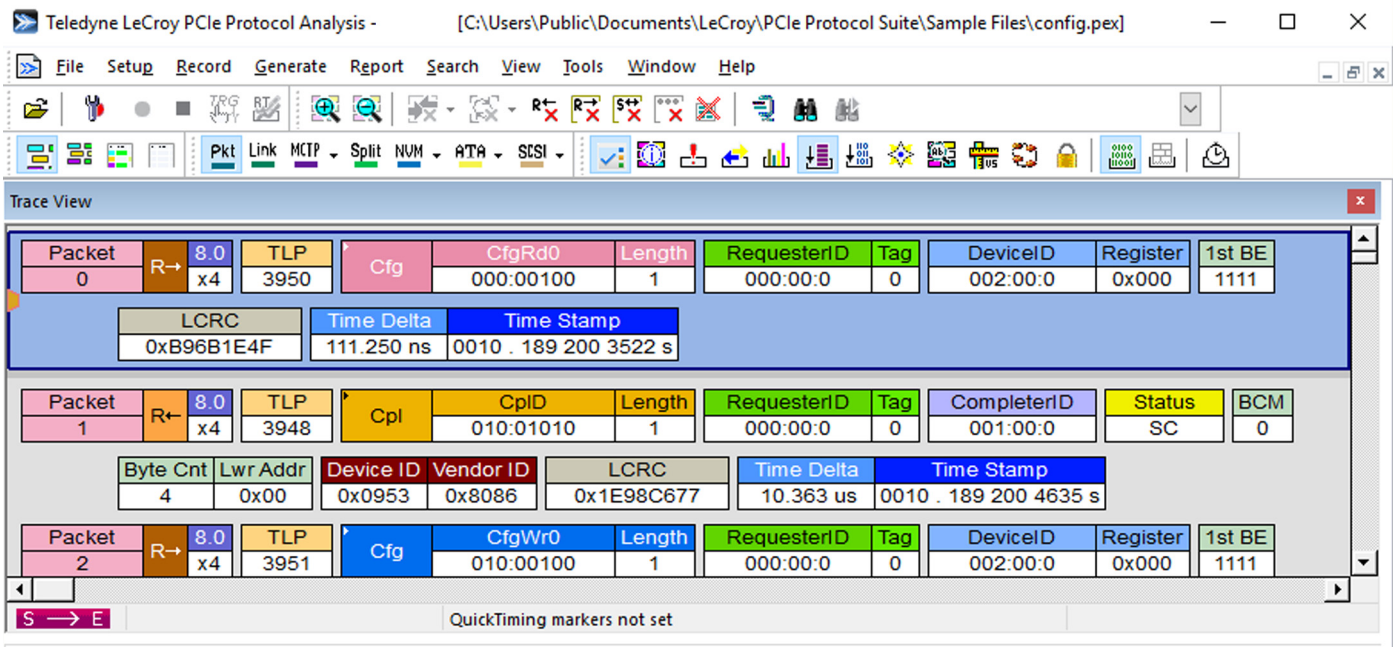
You can enter text and Search Previous or Search Next.

10.13 Configuration Space View

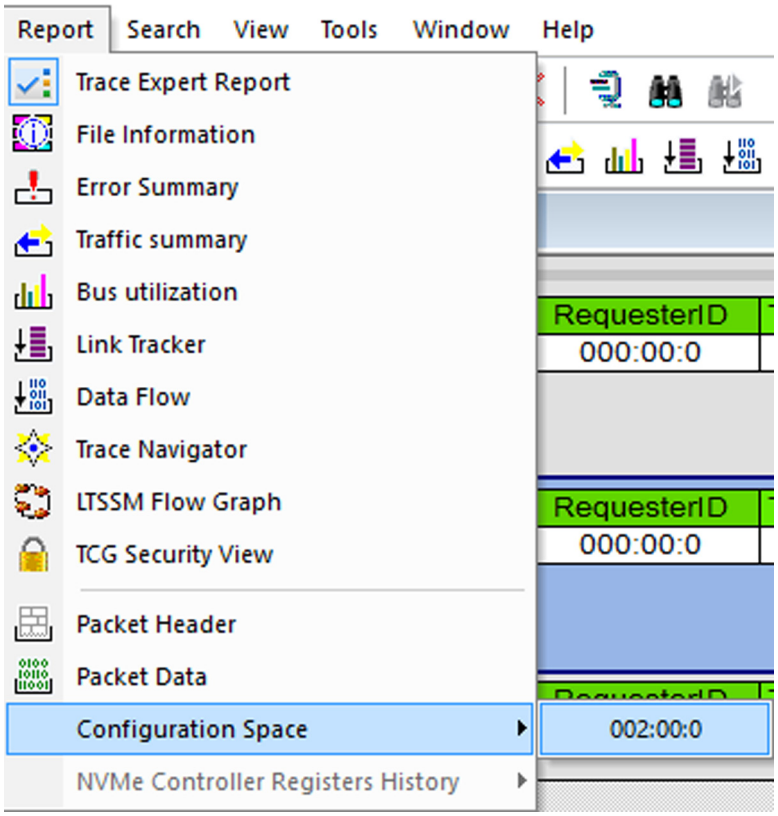
The Configuration Space View displays information about the Configuration Space state as of the current packet of the currently selected device. The view shows the Configuration Space Header and the PCI-compatible or PCI Express Capability Structures.

To display the Configuration Space View for a device at a packet:

1. Open a CATC Trace, such as the sample file **config.pex**.
2. Scroll to a packet with a Configuration header.



3. Select **Report > Configuration Space > <device>** to display the Configuration Space View.



Select **Show Configuration Space for xxxx** from the menu, where **xxxx** is the device number. The Configuration Space View displays (see Figure 10.50 on page 669).

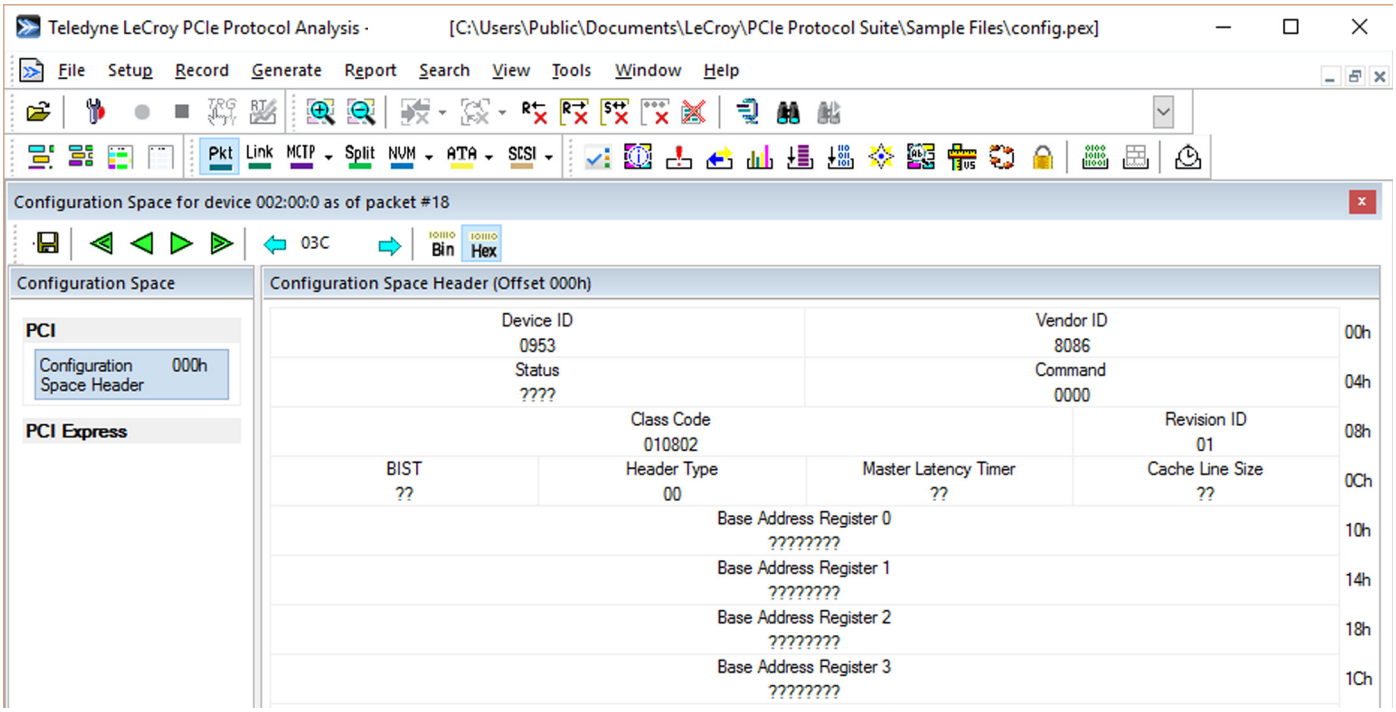


Figure 10.50: Configuration Space View

On the left, the view displays the Configuration Space for the selected CompleterID or DeviceID at the current packet. You can select **Configuration Space Header** or a **Capability Structure.**

The right displays the decoded data of the selected Configuration Space Header or a Capability Structure, up to the current packet. (The decoding builds while navigating through the next packets.)

The Configuration Space View toolbar allows you to save, go to First, go to Previous, go to Next, go to Last, go to Previous Access to Selected Configuration Space Register, go to Next Access to Selected Configuration Space Register, and display Hexadecimal or Binary.



Note: See Appendix B "Configuration Space Decoding" on page 731.

If you select to Save the Configuration Space file, a dialog box will pop-up and you can save the file for future use in either of two formats:

- PCIe Trainer Configuration Space files
- HTML files

See Figure 10.51.

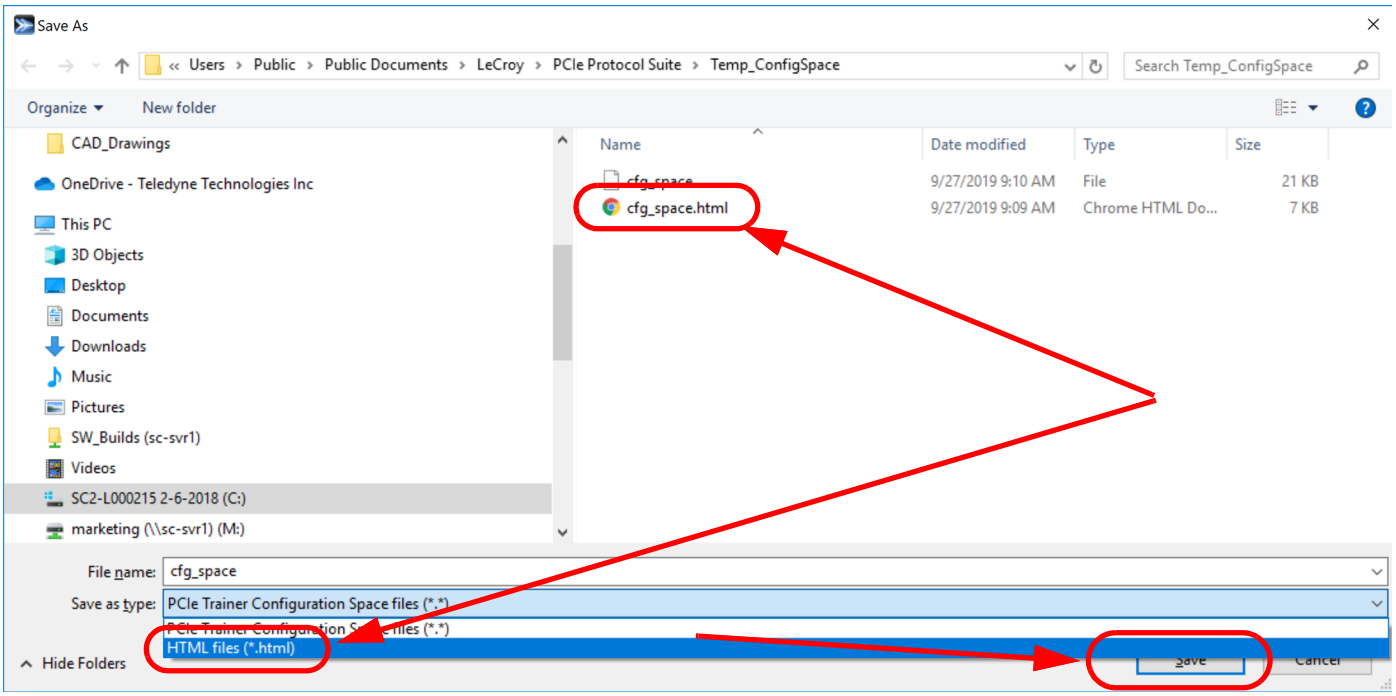
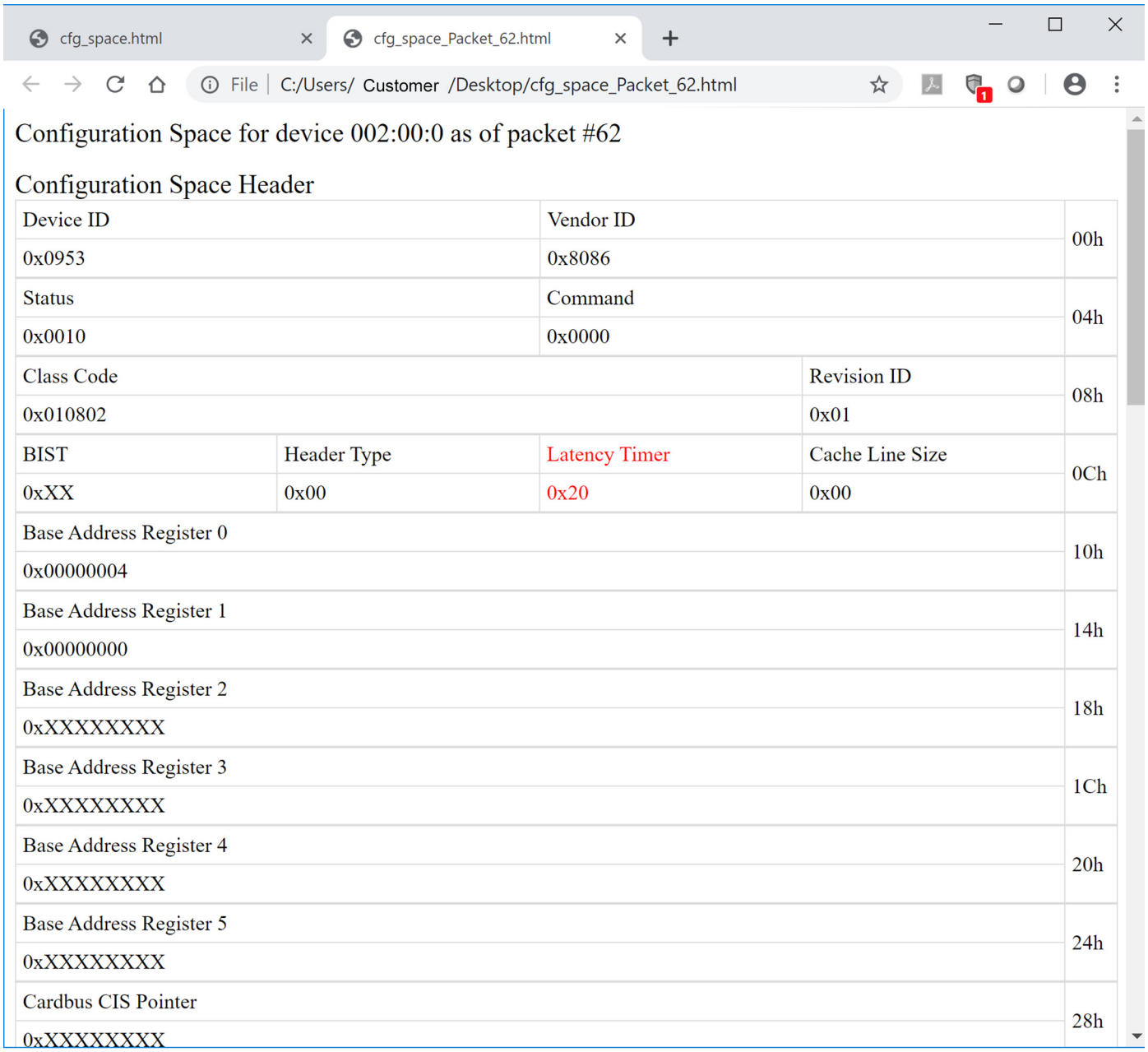


Figure 10.51: Location of Configuration Space File: PCIe Protocol Suite/Temp

Click on the **Save** button to save the file.

If you had selected Saving As -> HTML and you open that file, you will see the following information about the Configuration Space in HTML format. See Figure 10.52 on page 671.



Configuration Space for device 002:00:0 as of packet #62

Configuration Space Header

Device ID		Vendor ID		00h
0x0953		0x8086		
Status		Command		04h
0x0010		0x0000		
Class Code			Revision ID	08h
0x010802			0x01	
BIST	Header Type	Latency Timer	Cache Line Size	0Ch
0xXX	0x00	0x20	0x00	
Base Address Register 0				10h
0x00000004				
Base Address Register 1				14h
0x00000000				
Base Address Register 2				18h
0xXXXXXXXX				
Base Address Register 3				1Ch
0xXXXXXXXX				
Base Address Register 4				20h
0xXXXXXXXX				
Base Address Register 5				24h
0xXXXXXXXX				
Cardbus CIS Pointer				28h
0xXXXXXXXX				

Figure 10.52: Saving Configuration Space File As: HTML

10.13.1 Configuration Space Editor

The Configuration Space Editor allows you to create a new Configuration space file or open an existing Configuration Space file. It is used in conjunction with Teledyne LeCroy Trainer products. Select **Tools > Configuration Space Editor** to display the Configuration Space Editor dialog (see Figure 10.53 on page 672).

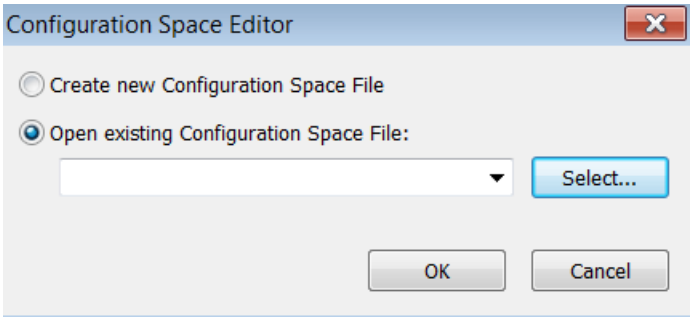


Figure 10.53: Configuration Space Editor Dialog

10.14 Using Unit Metrics

For every protocol unit at the Link or Split transaction level, PCIe Protocol Analysis™ calculates and displays a set of metrics. Metrics are measurements of key operating parameters. You can use metrics to evaluate performance of traffic in the CATC Trace stream.

You can view metrics information in the CATC Trace display, the Traffic Summary window, and the Bus Utilization window.

PCIe Protocol Analysis defines different metrics for Link and Split transactions.

10.15 Metrics Defined for Link Transactions

- **Number of Packets**: The total number of packets that compose this Link transaction.
- **Payload**: The number of data payload bytes this Link transaction transferred.
- **Response Time**: The time it took to transmit this Link transaction on the PE link, from the beginning of the first packet in the transaction to the end of the last packet in the transaction.
- **Data Throughput**: The payload divided by response time, expressed in megabytes (MB) per second (MB = 1024*1024 bytes).

Note: Usually, the Number of Packets metric for a link transaction is two (in case of explicit acknowledge) or one (in case of implicit acknowledge). However if Naks/link level retries are involved, this metric might be higher. As a result, the Number of Packets metric is useful in highlighting unusual link transactions.

10.15.1 Metrics Defined for Split Transactions

The following types of metrics currently are defined for Split transactions:

Number of Link Transactions: The total number of Link transactions that compose this Split transaction.

Payload: The number of payload bytes this Split transaction transferred.

Response Time: The time it took to transmit this Split transaction on the PE link, from the beginning of the first packet in the Split transaction to the end of the last packet in the Split transaction;

Data Throughput: The transaction payload divided by response time, expressed in megabytes (MB) per second (MB = 1024*1024 bytes).

Latency Time: The time measured from the end of the request transaction to the first completion transmitted in response to the request within this Split transaction.

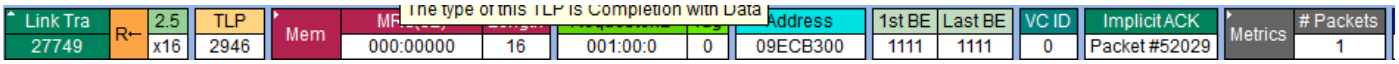
Note: The Number Of Link Transactions metric for a Split Transaction usually is two for a Configuration or IO request. It can be bigger then two for a Memory Read request.

10.16 Show Metrics in the CATC Trace Display

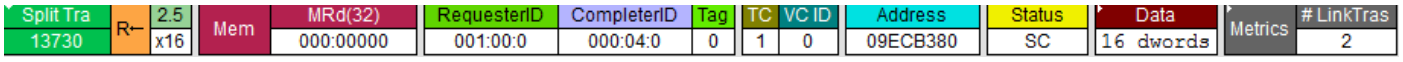
In the CATC Trace view display of Link Transaction or Split Transaction levels, all metrics information applicable to a specific protocol unit is displayed in a Metrics header. The header is located close to the end of the unit, in front of the Time cell. You can expand and collapse the header to show or hide the metrics information.

10.16.1 Collapsed Metrics Header Display

Following is a collapsed metrics display for a unit of Link Transaction. The collapsed header display shows only the metrics cell representing the Number of Packets.

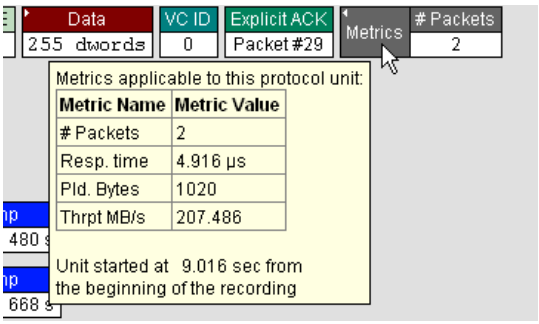


Following is a collapsed metrics display for a unit of Split Transaction. The collapsed header display shows only the metrics cell representing Number of Link Transactions.



10.16.2 Metrics Tool Tip Display

In both CATC Trace level views, you can view the summary of all the unit metrics in the Metrics header tool tip. To view the tool tip, simply place the mouse cursor over the Metrics header. Following is the tool tip for a unit in the Link Transaction view.

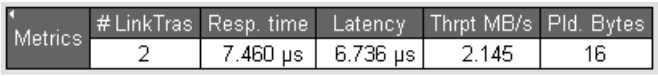


Note: The tool tip also presents information for time passed from the start of the recording till the beginning of this Link or Split Transaction.

10.16.3 Expanded Metrics Header Display

When you expand the Metrics header, the display creates a separate cell for each applicable metric:

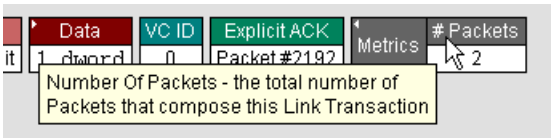
The following is the expanded Metric header for a unit in the Split Transaction view.



The following is the expanded Metric header for a unit in the Link Transaction view.



Note: Each of the metric cells pops up a tool tip window with the explanation of what the metric means.

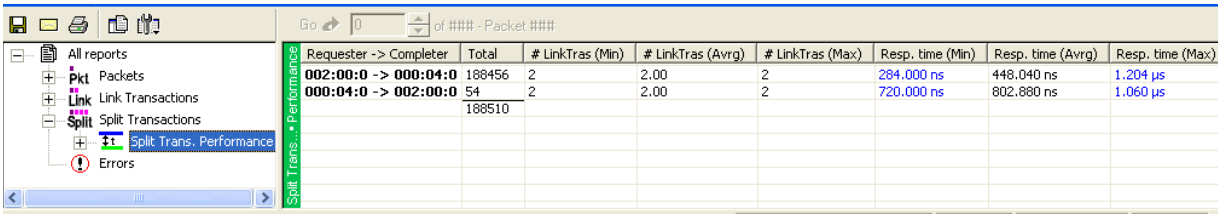


10.17 Show Metrics in the Traffic Summary Window

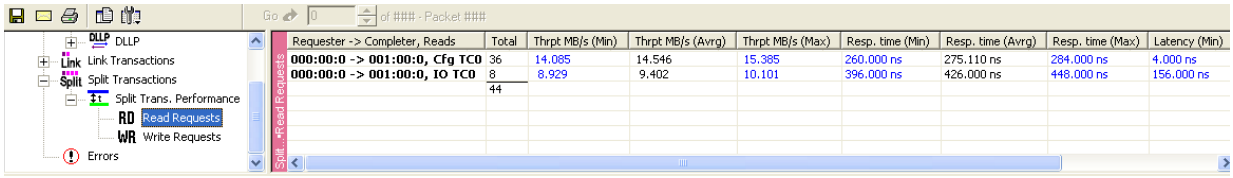
Some of the Traffic Summary reports at the Link and Split Transaction levels are based on metrics collected for the corresponding protocol units in the CATC Trace.

10.17.1 Reports at Split Transaction Level

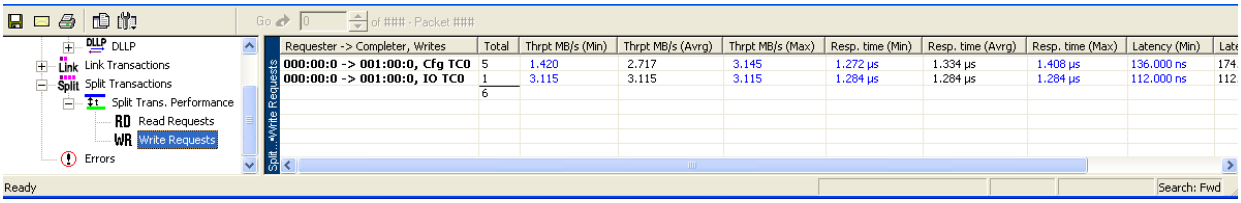
Split Transaction Performance: This report table groups the Split Transactions by Requester-Completer pair and displays Minimum/Average/Maximum data for Number Of Link Transactions and Response Time metrics.



Read Requests Performance: This report table includes only the Split Transactions that present Read Requests (Configuration, IO and Memory). It groups them by the combination of Requester-Completer pair, request type, and Traffic Class and displays Minimum/Average/Maximum data for Throughput, Response Time, and Latency metrics (see the following figure).



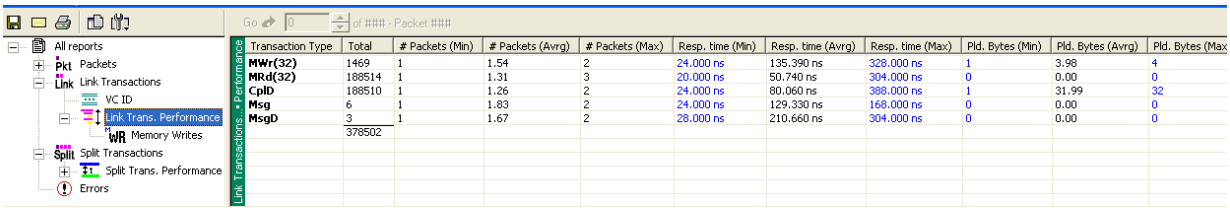
Write Requests Performance: This report table includes only the Split Transactions that present Write Requests (Configuration and IO). It groups them by the combination of Requester-Completer pair, request type, and Traffic Class and displays Minimum/Average/Maximum data for Throughput, Response Time, and Latency metrics.



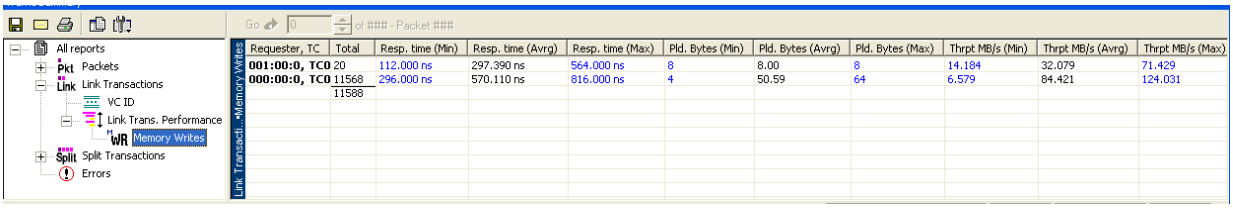
10.17.2 Reports at the Link Transaction Level

The following metric-based reports are displayed at the Link Transaction level:

Link Transaction Performance: This report table groups the Link Transactions by TLP Type and displays Minimum/Average/Maximum data for Number Of Packets, Response Time and Payload Bytes metrics.



Memory Writes: This report table includes only the Link Transactions that present Memory Write Requests. Memory Writes are the only (posted) requests that don't get promoted to the Split transaction level, therefore their performance should be viewed at the Link transaction level. The table groups Memory Writes by the combination of Requester ID and Traffic Class and displays Minimum/Average/Maximum data for Response Time, Payload and Throughput metrics.



The following features apply to all of the report tables described above for the Split Transaction and Link Transaction levels:

- Each report row for the defined tables contains the total number of units in this group for the CATC Trace (total number of units for Split Transaction performance, Read Requests performance, Memory Writes, and so on).
- In many cases, the Maximum and Minimum values in the report tables are navigable. By clicking table cells, you reposition the corresponding CATC Trace view to the Split or Link Transaction that has yielded this maximum or minimum value. This can help you to find specific units in the CATC Trace, such as transactions that produced spikes in Response Time or Throughput.

10.18 Show Metrics in the Bus Utilization Window

The Bus Utilization window provides graphs for packet-level information in the CATC Trace. The window also provides graphs for information on Split and Link Transaction levels, plotted over time. The graphs for Split and Link Transaction levels are based on metrics collected for the transactions throughout the CATC Trace.

The seven graphs related to Split and Transaction levels are:

1. Pending Requests at Split Transaction level.
2. Response Time at Split Transaction level.
3. Latency Time at Split Transaction level.
4. Throughput Per Transaction at Split Transaction level.
5. Response Time and Latency Time at Split Transaction level (combined graph).
6. Response Time at Link Transaction level, for Memory Writes only.
7. Throughput at Link Transaction level, for Memory Writes only.

The following is an example of Bus Utilization window display of graph numbers 1, 4, 5, 6 and 7 (see the following figure):



10.18.1 Unit-Based Averaging

The Analyzer builds metric graphs using unit-based averaging (as opposed to time-based averaging). For the total duration of a certain request (or Memory Write transaction), the graph value is assumed equal to the corresponding metric for this request (transaction). If there are overlapping operations for a certain time period, then the value is calculated as an average of metric values for all the overlapped requests (transactions).

It is important to remember that the Analyzer uses unit-based averaging rather than time-based averaging. Time-based averaging can be misleading in some situations. For example, consider the Throughput Per Transaction graph. Sometimes, while many outstanding requests are in progress, latency (and response time) grows for each of the transactions, resulting in a lower throughput per transaction over time (which is reflected in the graph). This happens even though aggregated throughput across all the transactions is constant.

10.18.2 Bus Utilization Window Features

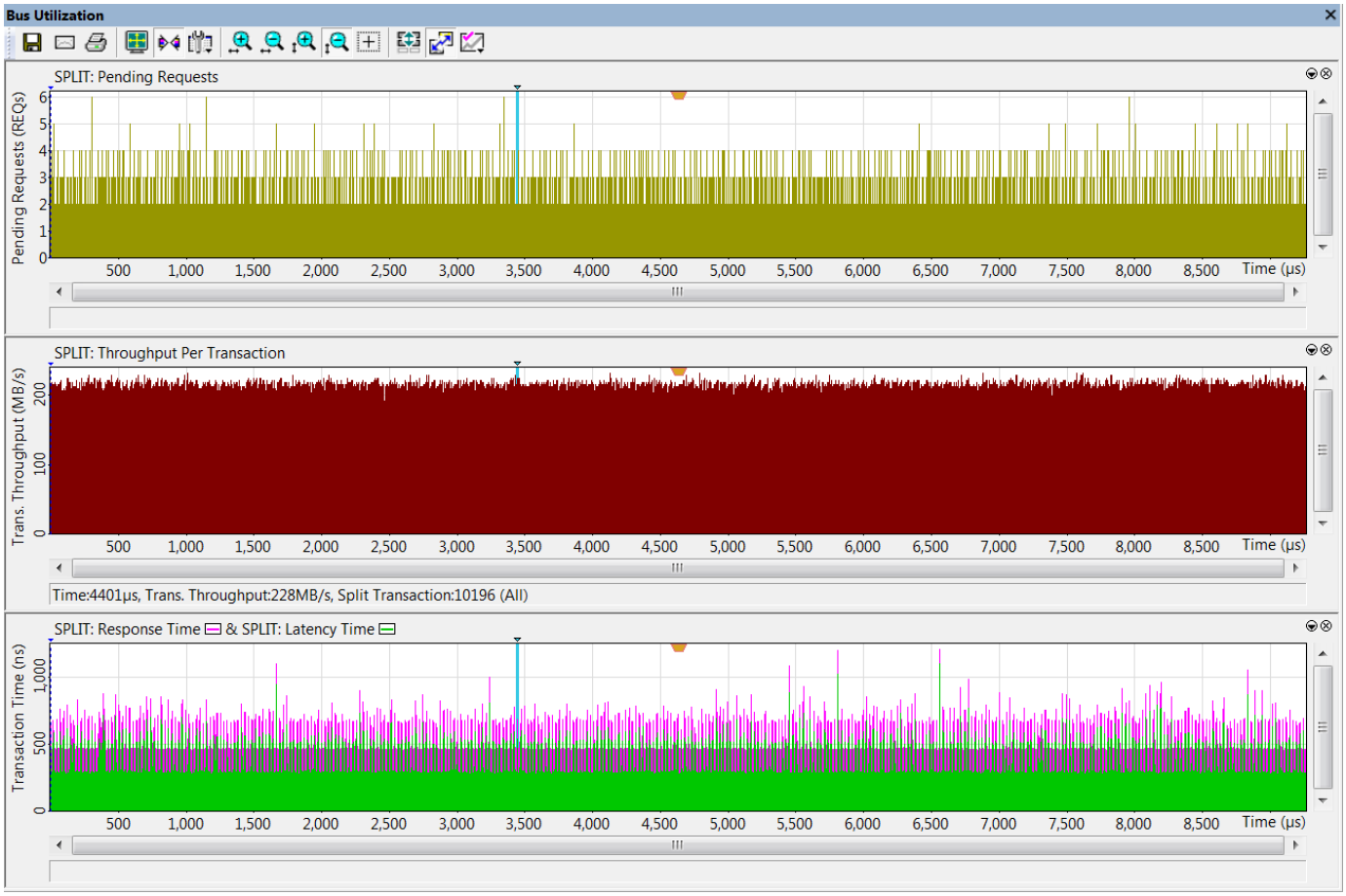
For the seven Split- and Transaction-level graphs listed, all Bus Utilization window features are available, such as zooming in/out, changing scale type, scrolling, context-sensitive status, and graph synchronization. See Bus Utilization and Bus Utilization Buttons for more on these features.

Note: Clicking a certain place within a graph area repositions the CATC Trace display at the Link or Split transaction level to the transaction that was in progress at that time.

10.18.3 Split Transaction Level Graphs

Transactions at the Split level combine all the non-posted requests with corresponding completions. This includes Configuration and IO Read and Write requests, as well as Memory Read requests.

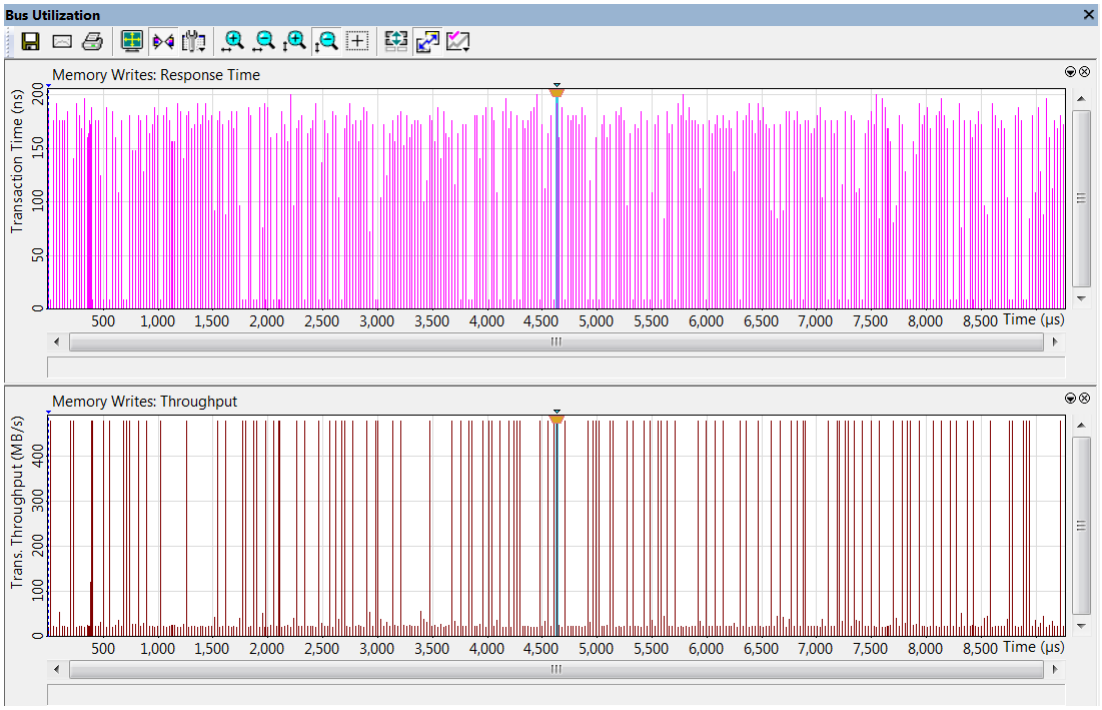
The following shows the graphs for the Split level:



Note: The Pending Requests graph is not directly defined by metrics, but it is useful when considering metrics. The Pending Requests graph presents the unit-averaged number of requests that were pending (in progress) at any moment of time. It allows you to correlate the number of requests posted to a completer with other performance metrics.

10.18.4 Link Transaction Level Graphs

Memory Writes are the only (posted) requests that do not get promoted to the Split transaction level. Therefore, Memory Write performance should be viewed at the Link Transaction level. That is the reason graphs at the Link level only present the Memory Write-related metrics and are titled **Writes: Response Time:** and **Writes: Throughput** (see the following figure).



10.19 Real-Time Statistics Window

The Real-Time Statistics Window displays Link Utilization, performance measurements, and statistical values for a PCI Express link plotted in real time.

Click 

to open the Real-Time Statistics window (see Figure 10.53 on page 672).

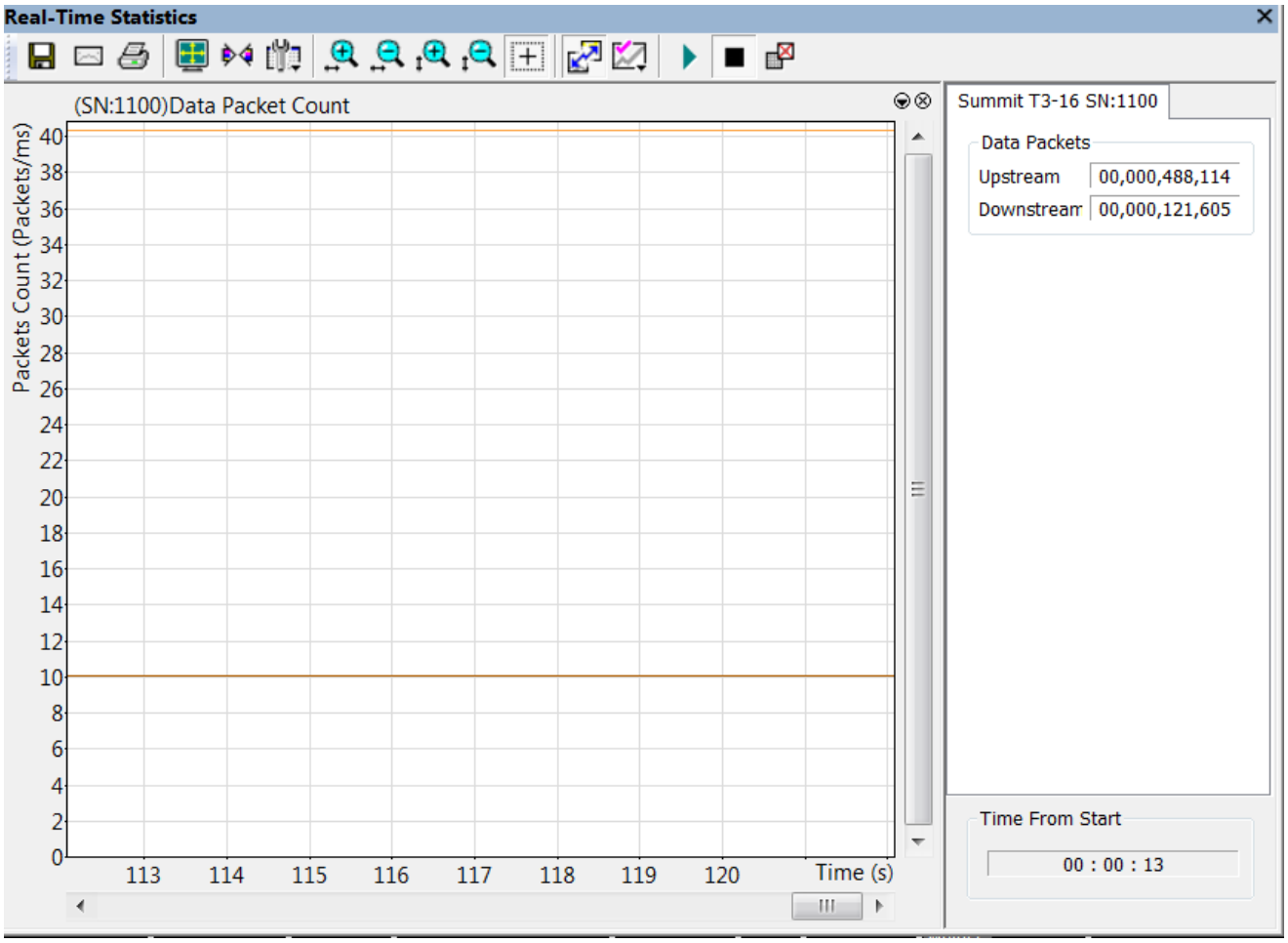


Figure 10.54: Real-Time Statistics Dialog

Start **PCI Express**™ link activity.

To start the monitor, press .

To stop the monitor, press .

The remaining Real-Time Statistics buttons provide options for changing the format of the display.

Additional formatting options are available through the Real-Time Statistics pop-up menu and the Real-Time Statistics toolbar.

10.19.1 Real-Time Statistics Buttons

Additional formatting options are available through the Real-Time Statistics toolbar.

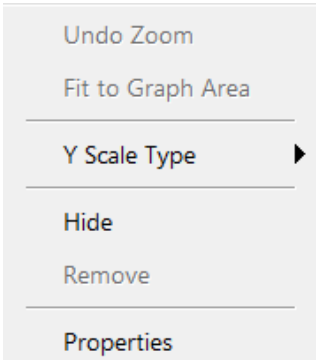


Button	Function
	Save. Saves Real-Time Statistics data to bitmap file (*.bmp).
	Email. Opens an email and attaches a bitmap file of the Real-Time Statistics data.
	Print. Prints the Real-Time Statistics data.
	Full Screen. Maximizes the Real-Time Statistics window.
	Synchronize Views.Synchronize the current view with other open views.
	View Settings. Opens a sub-menu with the following choices: •Orient Horizontally •Tile Vertically •Show Markers •Show Plumbline •Status >> •Bar •Tool tips •None •Grid Lines >> •Both Axes •X Axis •Y Axis •No Grid •Grid on Top •Fonts & Colors
	Horizontal zoom in
	Horizontal zoom out
	Vertical zoom in

	Vertical zoom out
	Click and Drag Zoom. Click and drag to zoom in on a part of the graph.
	Synchronize Graph Areas. If two or more graphs are displayed, this button synchronizes the graphs to one another. Once synchronized, the positioning slider of one graph moves the other graphs.
	Graph Areas. Allows you to hide or display the graphs and the counters. You can toggle Statistics Accumulation, Link Utilization, Data Payload Throughput, and Data Packet Count.
	Start real-time statistics. Starts the real-time statistical monitor.
	Stop real-time statistics. Stops the real-time statistical monitor.
	Reset Graphs. Resets the graphs.

10.19.2 Real-Time Statistical Monitor Pop-up Menu

Additional formatting options are available through the Real-Time Statistics pop-up menu. Right-click a graph in the Real-Time Statistical Monitor window to display a pop-up menu with options for changing the format of the display.



Undo Zoom: If you have zoomed in, this command undoes the zoom.

Fit to Graph Area: Redisplays graph so that the entire CATC Trace fits inside graph area.

Y Scale Type:

- **Linear**: Converts display to linear format.
- **Logarithmic**: Converts display to logarithmic format.

Hide: Hides the selected graph

Properties: Opens a dialog box with options for changing the Title, Appearance, and Color of the graph.

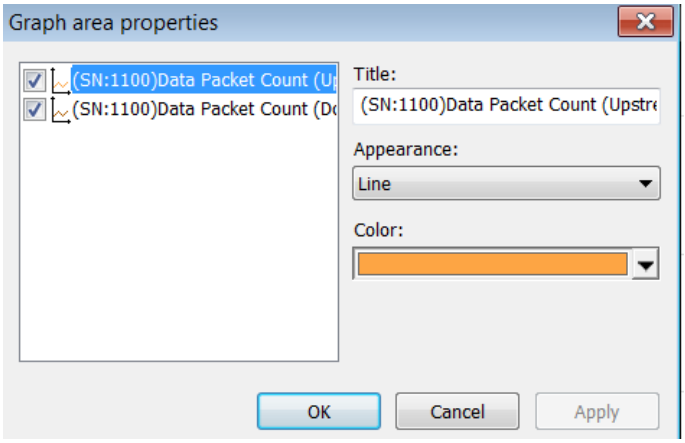


Figure 10.55: Graph Area Properties Display

10.19.3 Real-Time Statistics Graph Areas

The Real-time Statistics window has three graph areas:

- Link Utilization
- Data Payload Throughput

10.19.3.1 Data Packet Count

Each graph area has Upstream and Downstream graphs for a device (if connected to a host machine), plus as many graphs as Exerciser devices connected to the host machine.

The Statistics Accumulation area shows the PCIe Protocol Analysis statistics tab, plus as many tabs as Exerciser devices connected (see Figure 10.56 on page 684):

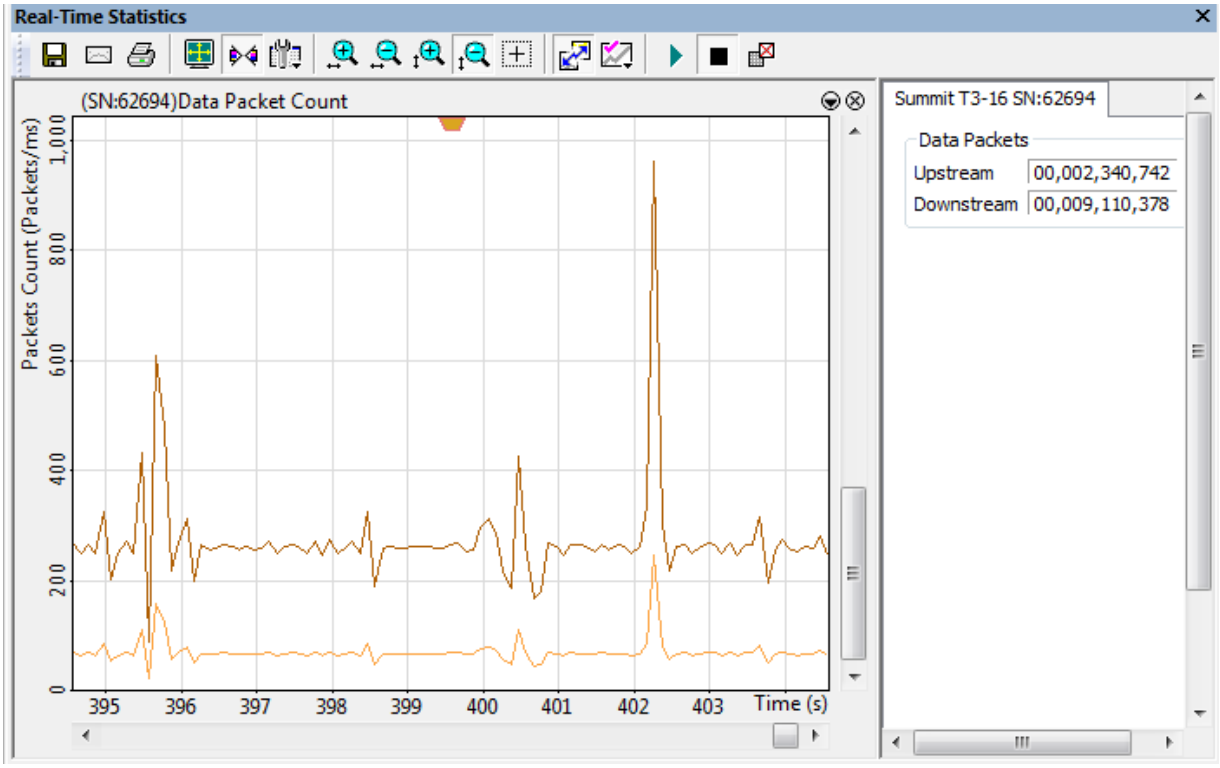


Figure 10.56: Real-Time Statistics Graph Display

For each Exerciser device, the following information is displayed:

- Number of data packets
- Payload size
- **InitFC complete status**: Yes/No
- **Link State**: Possible states are:
  - DETECT_QUIET
  - DETECT_ACTIVE
  - POLLING_ACTIVE
  - POLLING_CONFIG
  - CONFIG_LINKWIDTH_START
  - CONFIG_LINKWIDTH_ACCEPT
  - CONFIG_LANENUM_WAIT
  - CONFIG_LANENUM_ACCEPT
  - CONFIG_COMPLETE
  - CONFIG_IDLE
  - L0
  - L0S_IDLE
  - L0S_FTS
  - L1
  - RECOVERY_RCVRLOCK
  - RECOVERY_RCVRCFG
  - RECOVERY_IDLE
  - HOT_RESET

- DISABLED

10.20 Memory I/O Space Editor

The Memory I/O Space Editor allows you to create a new Memory I/O Space file or open an existing Memory I/O Space file. It is used in conjunction with Teledyne LeCroy Trainer products. Select **Tools > Memory I/O Space Editor** to display the Memory Space Editor dialog.

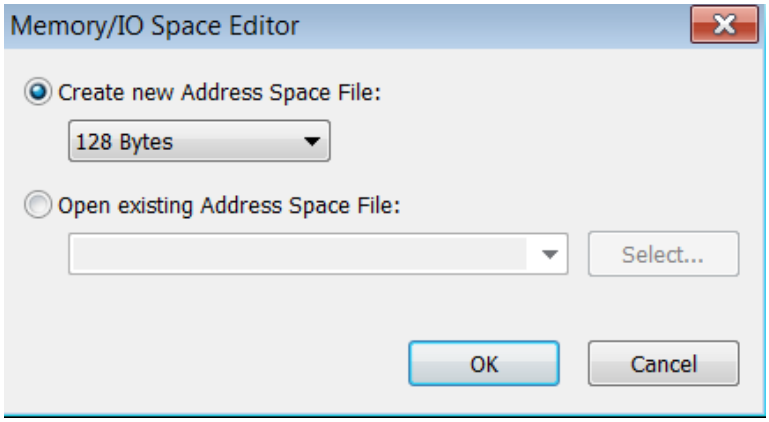


Figure 10.57: Memory I/O Space Editor Dialog

10.21 TC to VC Mapping

Select **Tools > TC to VC Mapping** displays how Traffic Classes are mapped to Virtual Channels (to simplify navigation) and how the CATC Trace display was changed (for example, in Split Transactions).

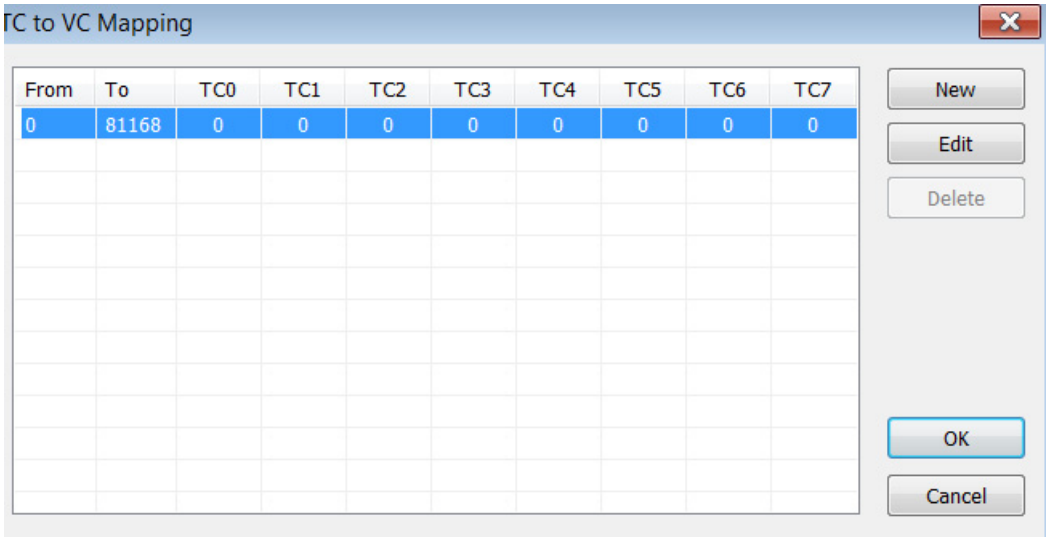


Figure 10.58: TC to VC Mapping Dialog

10.22 Timing and Bus Usage Calculations

10.22.1 Timing Calculator

Select **Tools > Timing Calculations** to obtain the Timing Calculator dialog.

The Timing and Bus Usage Calculator calculates PCIe timings, Queue Utilization and Total Input / Output. You can decide how much of a Trace you want analyzed. You can select the segment of the Trace you want analyzed by Packet (beginning to ending), Markers (chosen from the drop down) or Time (in seconds or clocks).

In this first case, we have an NVMe Trace loaded and are looking at the entire trace from the beginning of Packet 0 to the end of Packet 1714903. See Figure 10.59.

10.22.1.1 PCIe Timing Information: Entire Trace

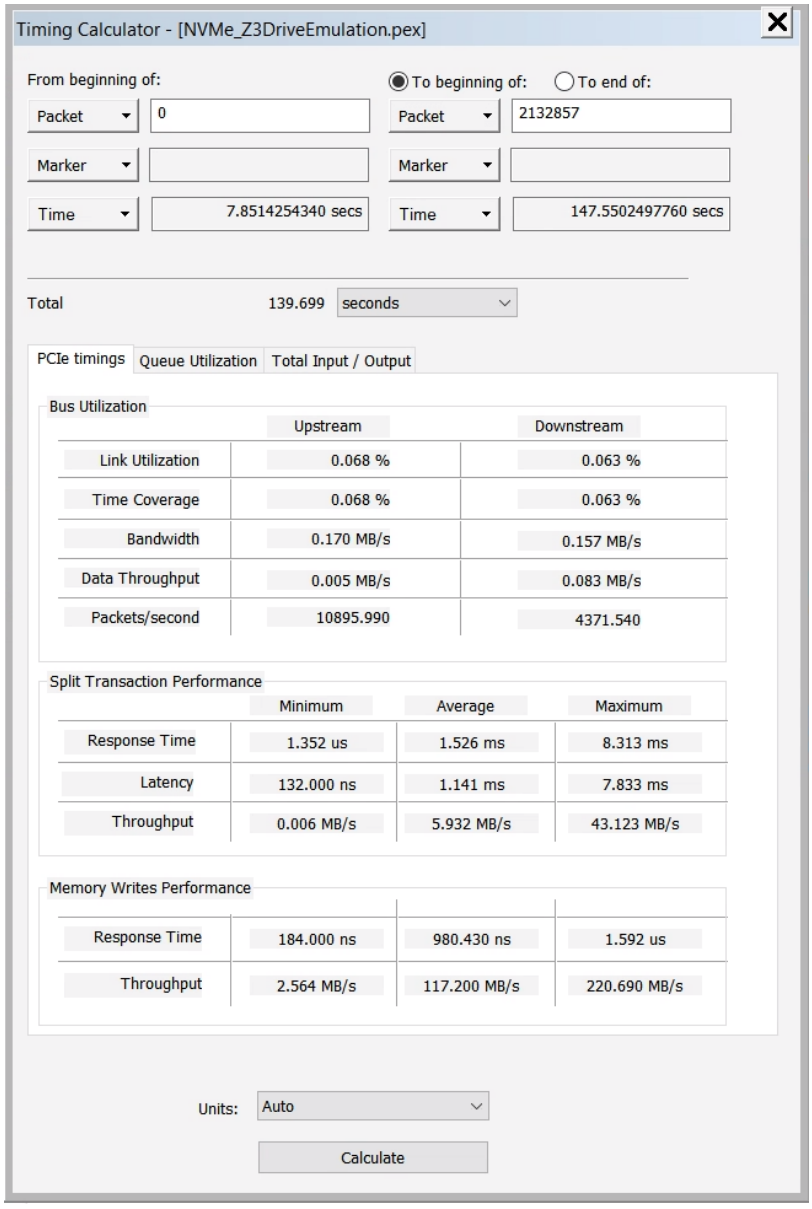


Figure 10.59: Timing Calculator for Entire Trace

The major portions of the PCIe Timings are discussed below:

10.22.1.2 Bus Utilization

This portion of the Timing Calculator window gives values that are cumulative for all packets during the timing period. For example, throughput is combined throughput of all packets during the timing period.

Upstream is from endpoint devices to the root complex. Downstream is from the root complex to endpoint devices.

Link Utilization: Percentage of non-idle symbols in total number of symbols transferred.

Time Coverage: Percentage of non-idle symbol times in total number of symbol times. (Non-idle symbol time occurs when at least on one of the lanes there were non-idle symbols transferred.)

Bandwidth: Number of non-idle symbol bits transferred per second.

Data Throughput: Number of TLP payload bytes transferred per second, expressed in MB per second (MB = 1024*1024 bytes).

Packets/second: Number of packets transferred per second.

10.22.1.3 Split Transaction Performance

This portion of the Timing Calculator window gives minimum, maximum, and average values for all Split transactions during the timing period. For example, minimum throughput is throughput of the Split transaction that passes the least amount of data. Maximum throughput is throughput of the Split transaction that passes the most amount of data. Average throughput is the average calculated for all Split transactions during the timing period.

Response Time: The time it took to transmit this Split transaction on the PE link, from the beginning of the first packet in the Split transaction to the end of the last packet in the Split transaction.

Latency: The time measured from the end of the request transaction to the first completion transmitted in response to the request within this Split transaction.

Throughput: The transaction payload divided by response time, expressed in megabytes per second, expressed in MB per second (MB = 1024*1024 bytes).

10.22.1.4 Memory Writes Performance

This portion of the Timing Calculator window gives minimum, maximum, and average values for all Memory Write transactions during the timing period. For example, minimum throughput is throughput of the Memory Write transaction that passes the least amount of data. Maximum throughput is throughput of the Memory Write transaction that passes the most amount of data. Average throughput is the average calculated for all Memory Write transactions during the timing period.

Response Time: The time it took to transmit this Memory Write on the PE link, from the beginning of the first packet in the Memory Write to the end of the last packet in the Memory Write.

Throughput: The Memory Write payload divided by response time, expressed in megabytes (MB) per second (MB = 1024*1024 bytes).

The Timing Calculator also has tabs for Queue Utilization and Total Input/Output. For the entire Trace the results are displayed below:

10.22.1.5 Queue Utilization

The Queue Utilization tool allows you to visualize the traffic on the submission queues (SQ) and command queues (CQ) within a time interval. The default interval is the entire trace. The graph is generated using the Calculate button at the bottom of the dialog (see Figure 10.60) below.

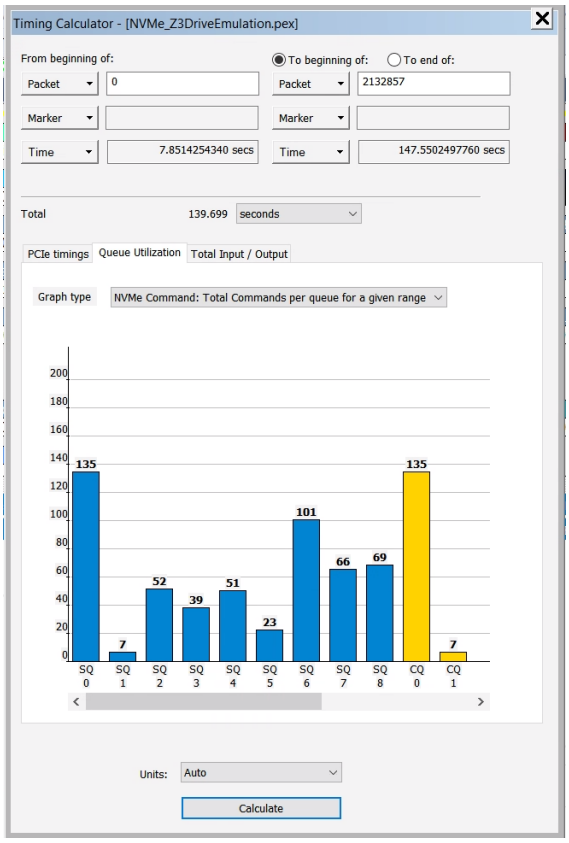


Figure 10.60: Timing Calculator: Queue Utilization

10.22.1.6 Total Input/Output

The Total Input / Output has two sections:

- Link/Split Total Traffic
- NVMe Command Total Traffic

See Figure 10.61

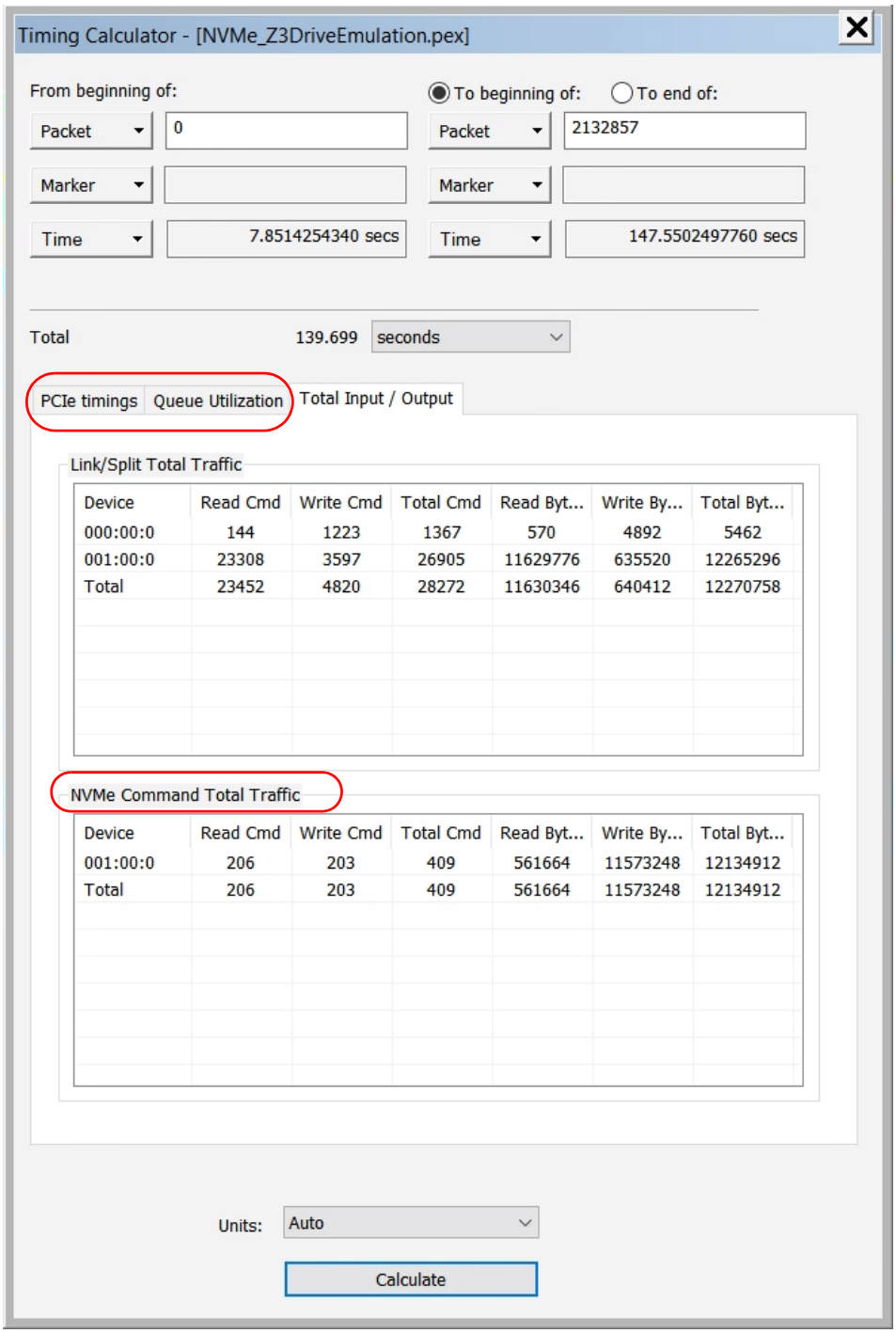


Figure 10.61: Timing Calculator: Total Input / Output

10.22.1.7 Timing Calculator Display Units

The Timing Calculator can display data in several different units by selecting the appropriate combo box value and hitting the Calculate button (see Figure 10.62).

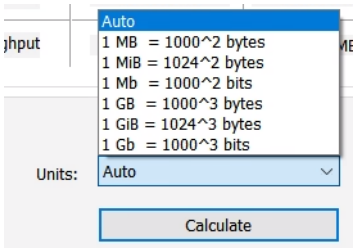


Figure 10.62: Timing Calculator: Unit Selection

The results are displayed in both MB and Mb format in Figure 10.63.

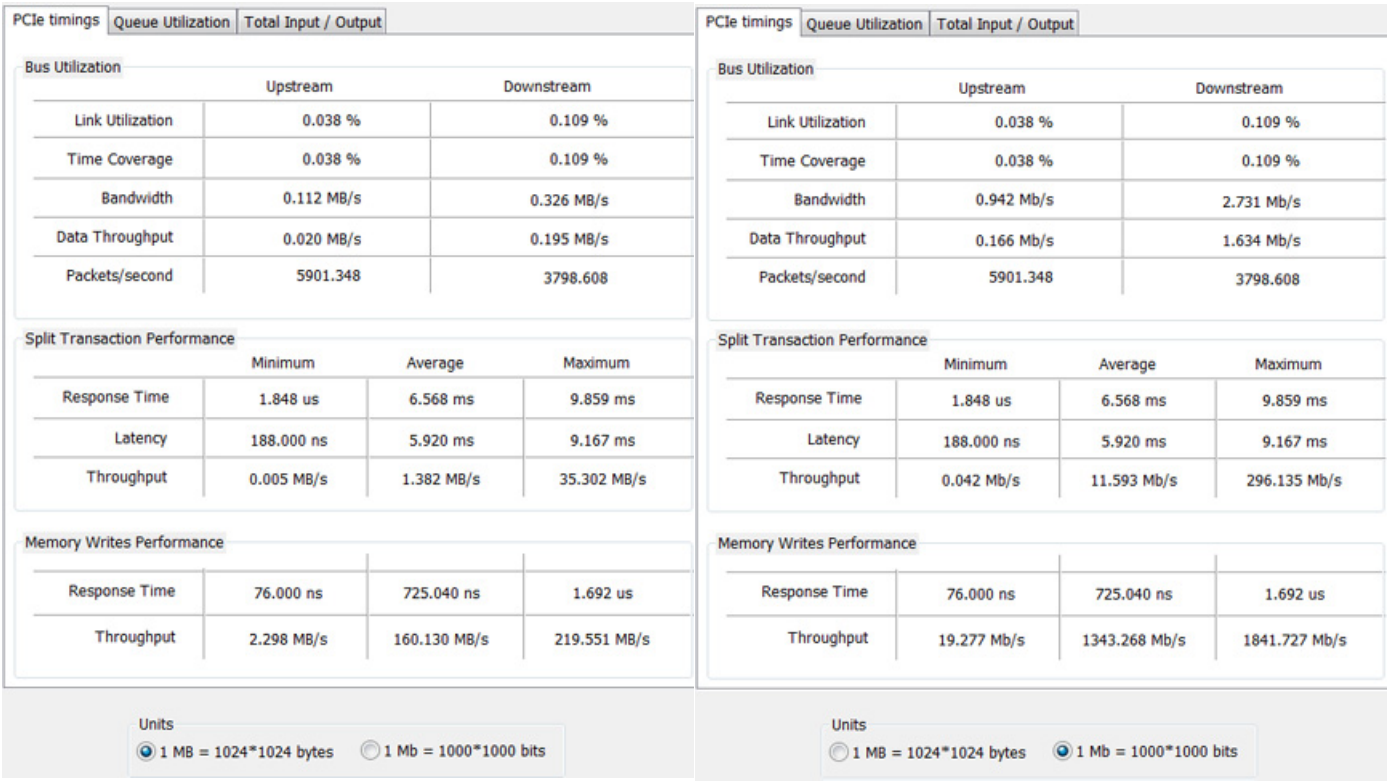


Figure 10.63: Timing Calculator: PCIe Timing Displayed in MB and Mb

10.22.2 Details of Timing Calculations

10.22.2.1 Timing From Beginning of Event to Beginning of Event or to End of Event

The Timing Calculator can calculate trace timing from the beginning of an event to either the beginning of another event or to the end of another event. See Figure 10.64.

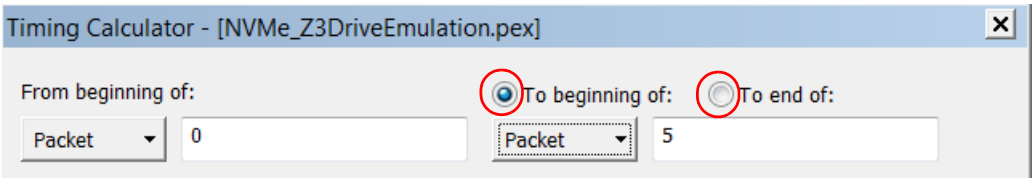


Figure 10.64: Timing Calculator: Beginning of Event to Beginning of Event or to End of Event

10.22.2.2 Types of Events

The Timing Calculator can also be used to look at specific events in more detail and has a variety of commands to help you parse the entire trace into segments of interest. The Timing Calculator can look at just Packets, Link Transactions, Split Transactions, NVMe Transactions or NVMe Commands. In this case, we have chosen NVMe Commands to explore in detail. See Figure 10.65.

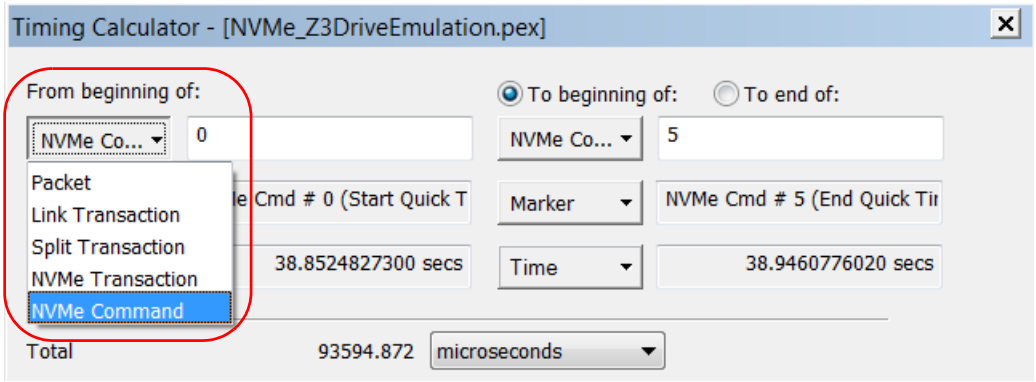


Figure 10.65: Timing Calculator: Types of Events

10.22.2.3 Displaying Time

The time can be displayed in nanoseconds, microseconds, milliseconds and seconds. See Figure 10.66.

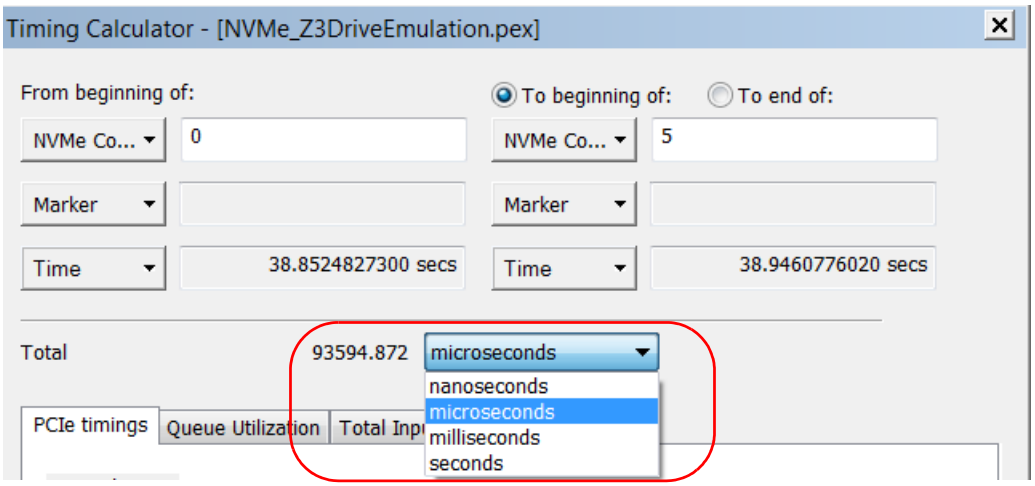


Figure 10.66: Timing Calculator: Timing Units

10.22.2.4 Markers

If Markers were set, they would be visible in the Marker pull-down (see Figure 10.67).

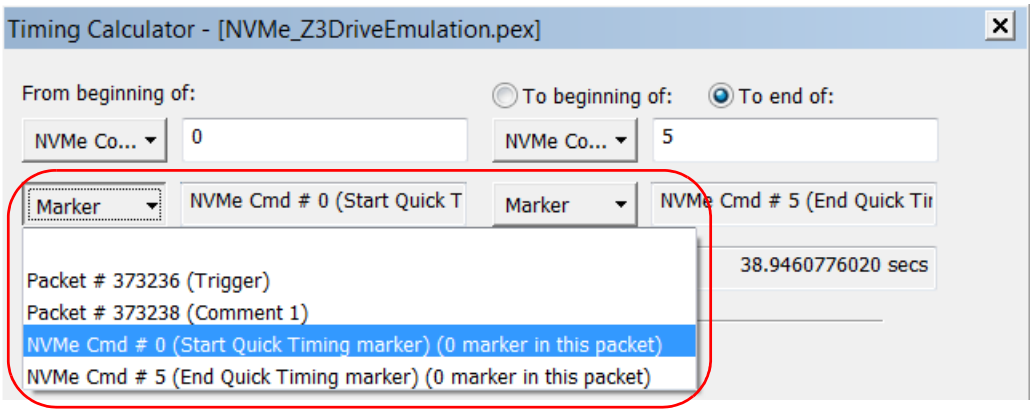


Figure 10.67: Timing Calculator: Markers Set

If the Trigger and Comment 1 Markers were chosen, the Timing Calculator would come up with the following results: see Figure 10.68 on page 693. As you can see from the results, the markers were only two packets apart.

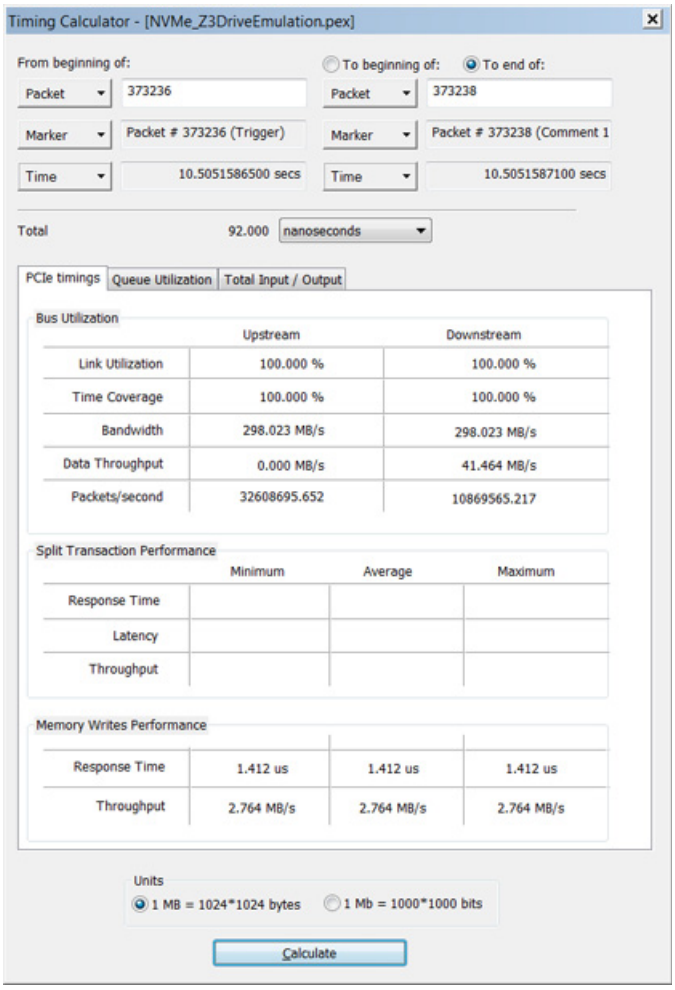


Figure 10.68: Timing Calculator: Results Between Markers

10.22.2.5 Timing To Beginning of NVMe Command

If NVMe Commands are selected the tool calculates timing information from the beginning of NVMe Command 0 to the beginning of NVMe Command 5. You can see that Total time is 93594.872 microseconds. See Figure 10.69.

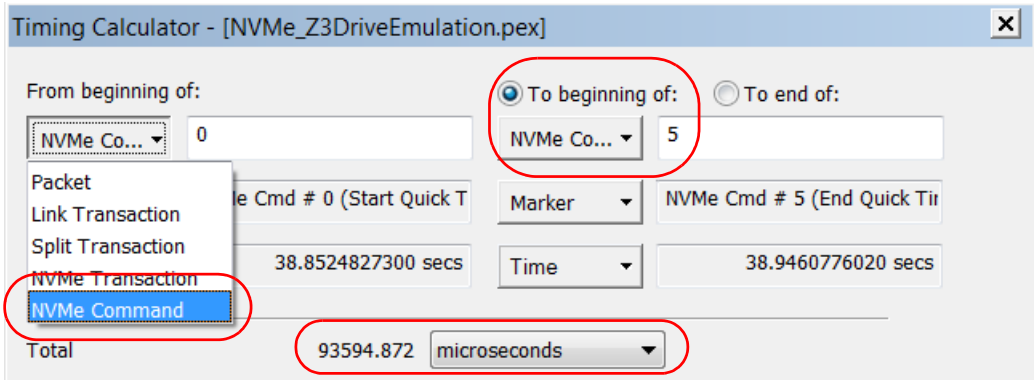


Figure 10.69: Timing Calculator: Selections for Timing Calculations

10.22.2.6 Timing To End of NVMe Command

If we had chosen to calculate the timing parameters "To end of": NVMe Command 5, the Total time would have included the NVMe Command 5 and the Total time is 93594.968 microseconds. See Figure 10.70 on page 694.

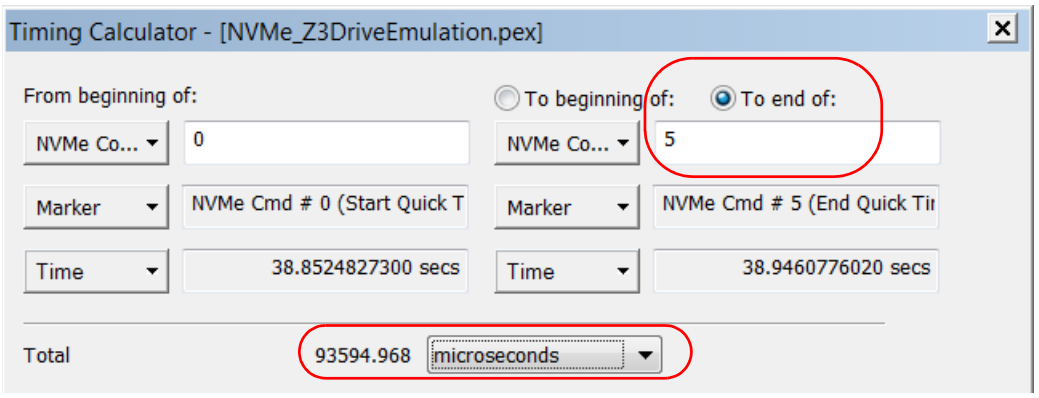


Figure 10.70: Timing Calculator: To end of NVMe Command 5

10.22.2.7 Results from Timing Calculator

The differences between the Timing Calculator results from the beginning of NVMe Command 0 to the beginning of NVMe Command 5 and to the end of NVMe Command 5 can be seen in Figure 10.71.

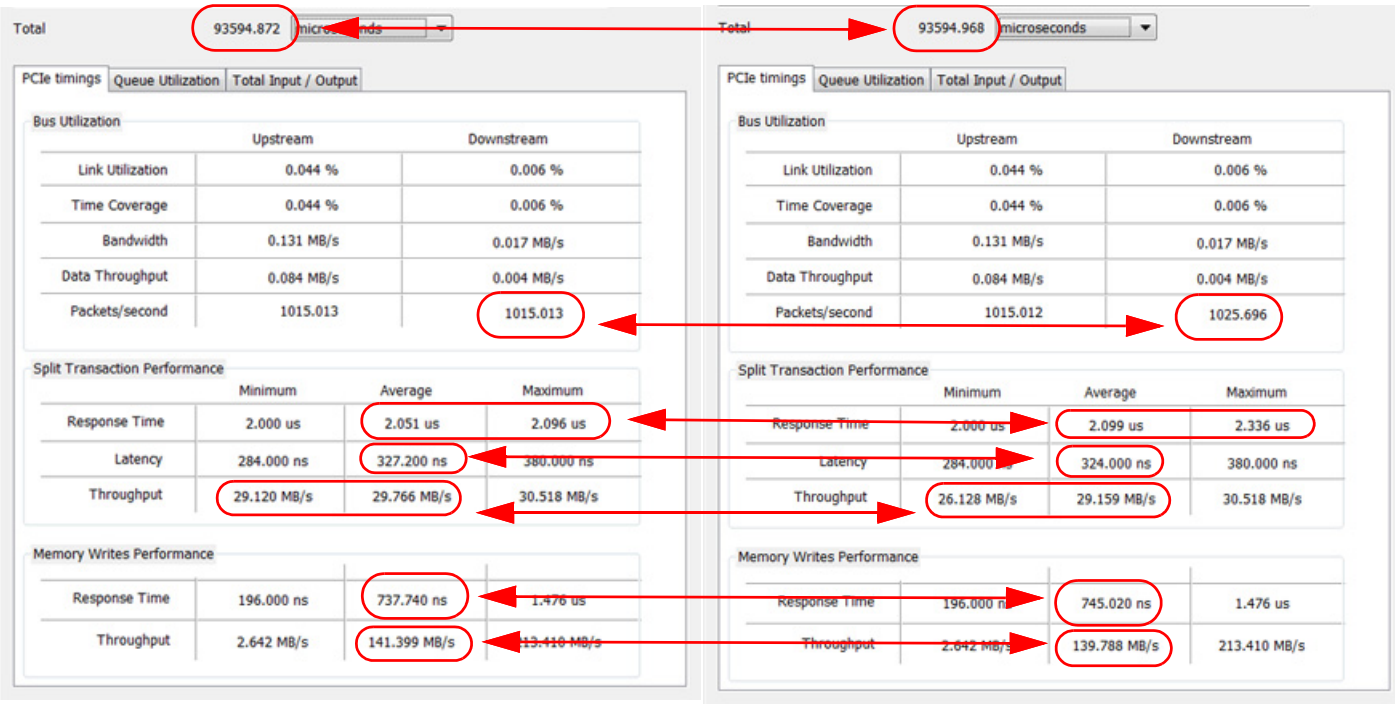


Figure 10.71: Timing Calculator: Beginning of NVMe Cmd 5 and Ending of NVMe Cmd 5 (MB)

Most of the results are the same except for Total time, Downstream Packets/second, Split Transaction Performance (Response Time, Latency and Throughput) and Memory Write Performance (Response Time: Average and Throughput: Average).

10.22.2.8 Timing to Beginning and End of Events: Effect on Queue Utilization

If we look at the differences between the Queue Utilization from the beginning of NVMe Command 0 to the Beginning of NVMe Command 5 and to the Ending of NVMe Command 5 you'll see one more NVMe Command in the Queue. See Figure 10.72.

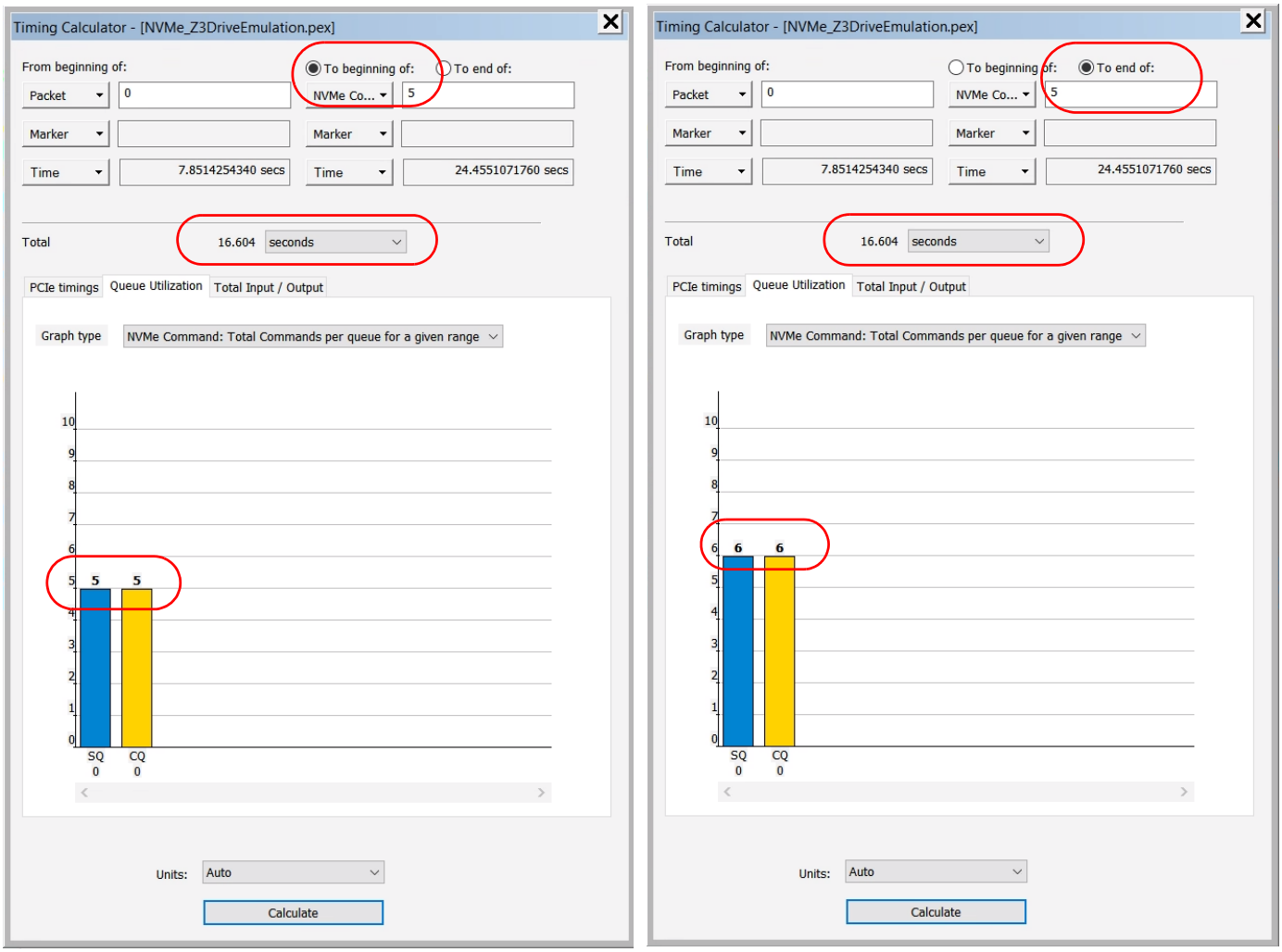


Figure 10.72: Timing Calculator: Queue Utilization

10.22.2.9 Timing to Beginning and End of Events: Effect on Total Input / Output

If we look at the differences between the Total Input / Output graphs from the beginning of NVMe Command 0 to the Beginning of NVMe Command 5 and Ending of NVMe Command 5 you'll see one more Write Command. See Figure 10.73.

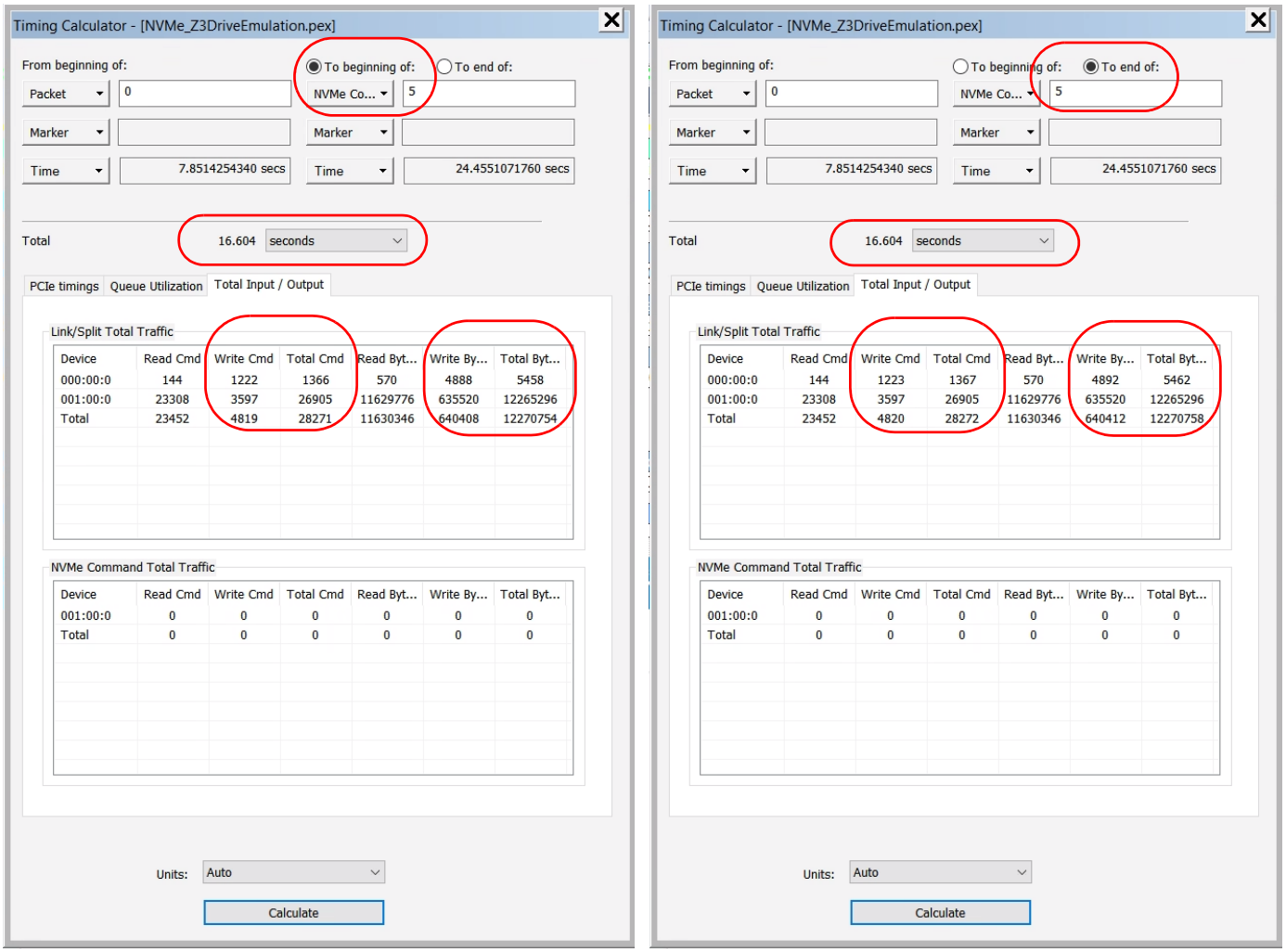


Figure 10.73: Timing Calculator: Differences in Total Input / Output

The two displays show that including NVMe Command 5 adds one more Write Command and it's associated number of bytes.

10.23 PCIe SSD Base Address Mapping

In order for NVMe, PQI, AHCI, ATA, SOP and SCSI decoding to work correctly, the PCIe Protocol Analysis needs to know the Memory Base Address of the device.

If the Base Address assignment is not present in the trace, you can specify the values manually using this dialog. You need to select the type of the device (NVMe, PQI, AHCI, ATA, SOP or SCSI) and set the value of the Base Address by selecting **Tools > PCIe SSD Base Address Mapping.** See Figure 10.74.

10.23.1 Base Address Not Record in Trace

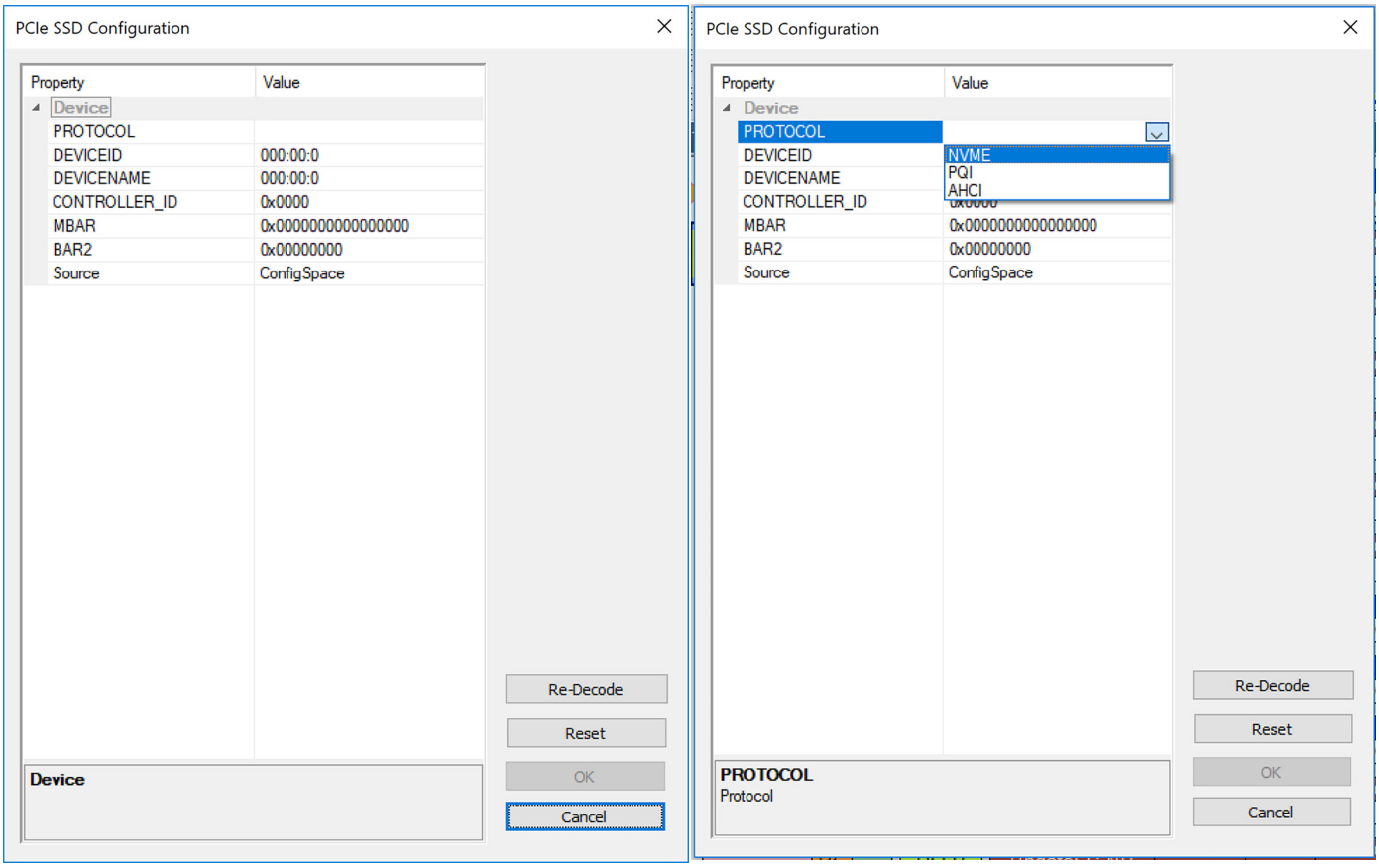


Figure 10.74: Trace without Protocol Type Specified

You must select the type of trace your recorded. In this case we selected NVME and the PCIe SSD Configuration dialog box is fully populated with all the NVME. See Figure 10.75 on page 698.

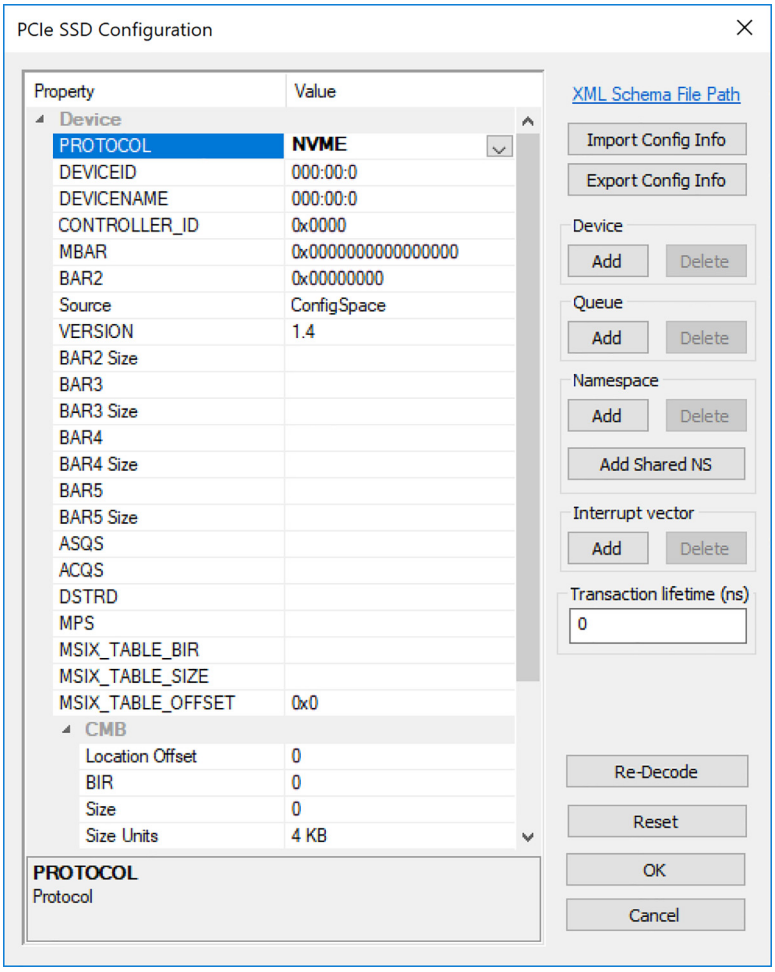


Figure 10.75: PCIe SSD Configuration dialog box populated with NVME options

10.23.2 Base Address Recorded in Trace

In cases when Base Address assignment is recorded in the trace, the software will determine all the values automatically. The PCIe SSD Configuration dialog displays (see Figure 10.76 on page 701).

Note: From software release 6.63 onwards, users are able to decode NVMe/PQI traces which are lacking configuration space and administration information, from release 6.70 this is applicable to AHCI traces, from release 7.00 this is applicable to ATA traces and from release 7.10 this is applicable to SOP and SCSI traces.

Note: From software release 7.30 onwards, multiple NVMe devices can be decoded from the same trace.

Note: From software release 7.34 onwards, the SSD Dialog displays the Device Name as read in the configuration accesses.

Note: From software release 7.38 onwards, while the SSD Dialog is open, the Trace View is scrollable.

Follow the steps below to perform the applicable storage decoding:

1. Record the trace for NVMe, PQI, AHCI, ATA, SOP or SCSI device boot and decode it.
   This saves the configuration space and administration information in .xml format, which is used to decode traces that do not include configuration and administration commands.
2. Record the trace of the same NVMe, PQI, AHCI, ATA SOP or SCSI device without rebooting and the application will decode it.

You can keep recording and decoding until rebooting. On reboot repeat steps 1 and 2 above.

10.23.3 NVMe PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 10.76 on page 701 for NVMe PCIe SSD Device Configuration.

Prior to decoding, if all the required information is available in Configuration Space then the Source field in the PCIe SSD Configuration will be set to "Config Space" (see Figure 10.76 on page 701). The description for important fields and buttons are given below:

1. DEVICE ID: Represents the device ID in the bus/device/function address from the PCIe specification (ID Based routing).
2. DEVICENAME: Device Name
3. MBAR: The MBAR field in this dialog is required and editable. Make sure that the information entered is correct. Click on any field and the description displays in the bottom read-only box. The 64-bit main address bar (i.e. BAR1:BAR0). Without this value decoding cannot be done. It should be in "0x" hex format.
4. BAR2:
5. PROTOCOL: Displays the current storage protocol decoded.
6. ASQS: Defines the size of the Admin Submission Queue in entries. Refer to the controller registers section of the NVMe specification. The minimum size of the Admin Submission Queue is two entries. The maximum size of the Admin Submission Queue is 4096 entries. This is a 0’s based value.
7. ACQS: Defines the size of the Admin Completion Queue in entries. Refer to the controller registers section of the NVMe specification. The minimum size of the Admin Completion Queue is two entries. The maximum size of the Admin Completion Queue is 4096 entries. This is a 0’s based value.
8. DSTRD: This register indicates the stride between doorbell registers. The stride is specified in bytes. This may be used to separate doorbells by a number of bytes in memory space. It may be useful in software emulation of an NVMe Express controller. For hardware implementations of NVMe Express, the expected doorbell stride value is 4.
9. LBASIZE: Size for Logical Block Addressing.

10. MPS: This field indicates the host memory page in bytes.
11. IOCQES: I/O Completion Queue Entry Size. This field defines the I/O Completion Queue entry size that is used for the selected I/O Command Set. The required and maximum values for this field are specified in the Identify Controller data structure for each I/O Command Set. The value is in bytes and is specified as a power of two (2^n).
12. IOSQES: I/O Submission Queue Entry Size. This field defines the I/O Submission Queue entry size that is used for the selected I/O Command Set. The required and maximum values for this field are specified in the Identify Controller data structure for each I/O Command Set. The value is in bytes and is specified as a power of two (2^n).
13. MQES: Maximum Queue Entries Supported. Defines the maximum individual queue size that the controller supports. This is a 0's based value. The minimum value is 1h, indicating two entries.
14. Source: Source of the data.
15. Queues: Under this node the user can add more missing nodes to decode the current trace. Click the **Add Queue** or **Delete Queue** button to add or delete a queue node. Type based on the user selection.
16. XML Schema File Path: Selecting this link pops up a window with the location of the XML Schema File. It is also available in TechBrief_Use_of_NVMe_xml_schema.pdf in the installation AppNotes\ directory.
17. Import Config Info: Click to Import configuration information.
18. Export Config Info: Click to Export configuration information.
19. Add Device/Delete Device: Click to add/delete device (NVMe/PQI only).
20. Add Queue/Delete Queue: Click to add/delete queue (NVMe/PQI only).
21. Add Namespace/Delete Namespace: Click to add/delete a new namespace if this information is not present in a trace file (NVMe/PQI only).
22. Interrupt Vector: Add/Delete an Interrupt Vector to a selected Device (see "Interrupts" on page 702).
23. Re-Decode: Click to re-decode.
24. Reset: Click to reset.
25. OK: Click to accept the settings.
26. Cancel: Click to cancel the settings.

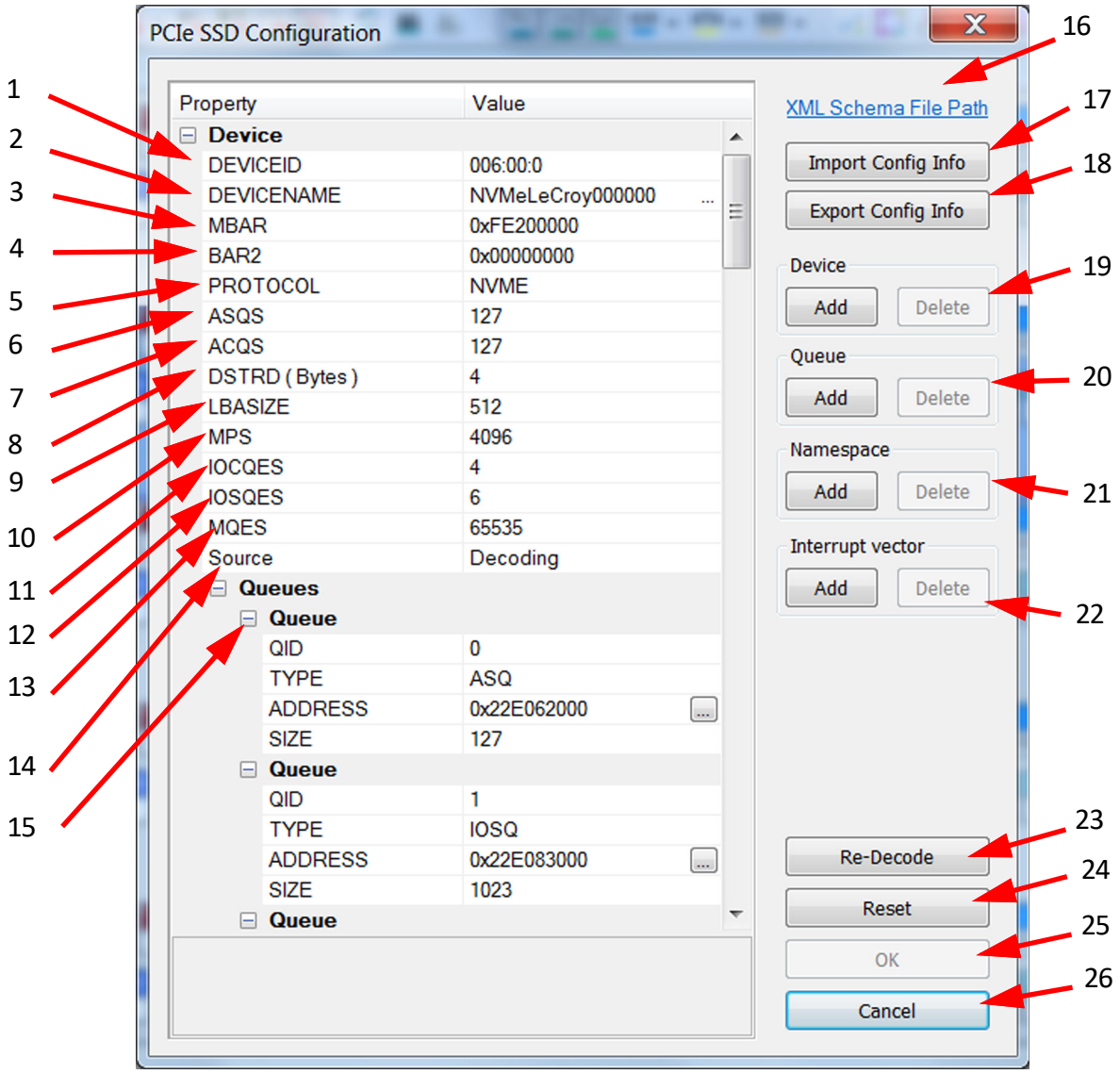


Figure 10.76: PCIe SSD Configuration Dialog Pre-decoding

Select any of the options in the 

drop down menu item to decode the trace and select **Tools > PCIe SSD Base Address Mapping** (see Figure 10.78).

Note: When opening a trace file created with 7.0X or older versions of PCIe Protocol Analysis, these new fields are not present and the application tries to export the configuration information to XML before decoding NVMe transaction level. In this case a message box will show claiming that a value for this field is required.

Note: In case of problems when opening older traces try the following: a) Decode NVMe transaction level before exporting XML file. This will apply the default value for the new fields and export can be performed. b) Manually enter the values for the new fields. c) In case the trace contains submission entries which are not decoded, add a new Queue and set the corresponding address in the PCIe SSD Configuration dialog.

10.23.3.1 Interrupts

MSI and MSI-x interrupts are decoded at configuration time and include the vector offset and address. These values can be added/deleted/modified by the user to add data that may not have been captured in the trace.

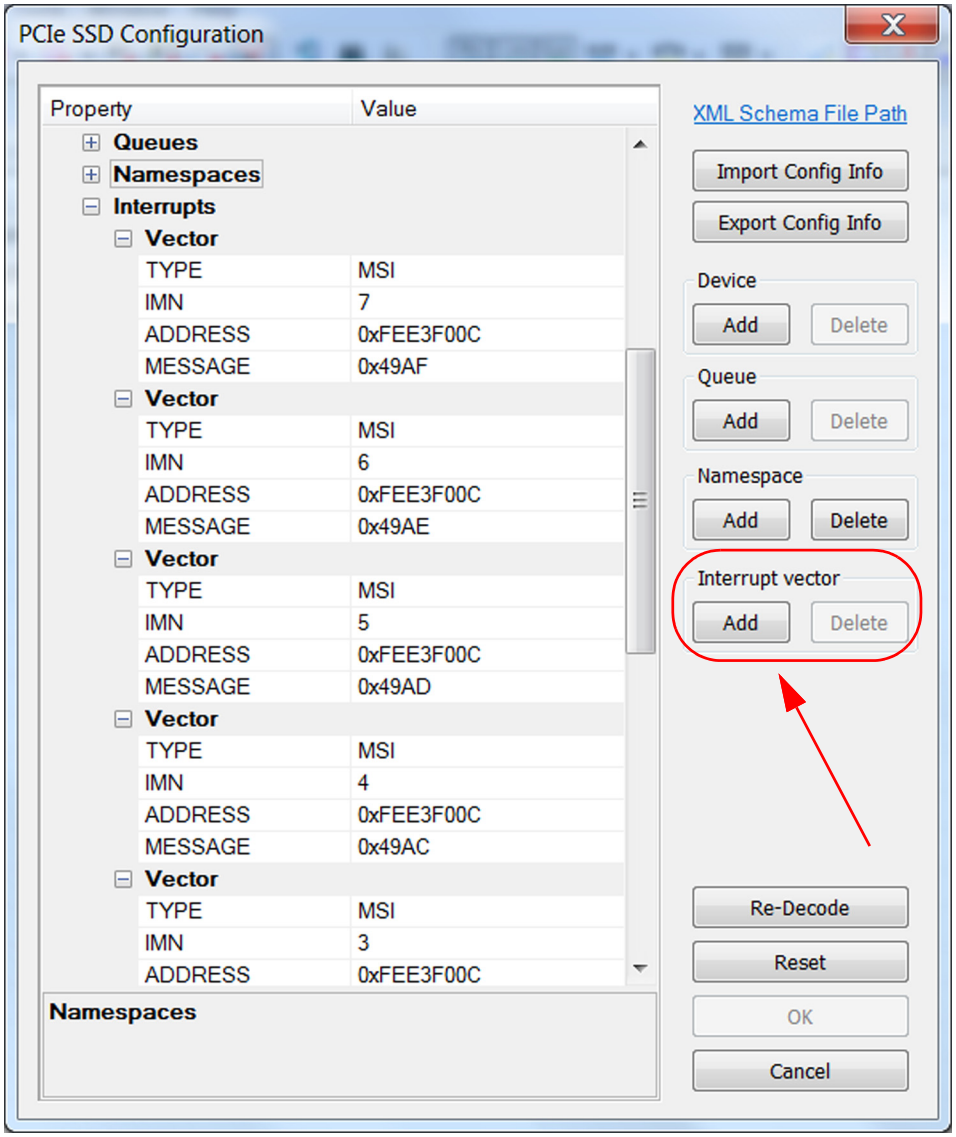


Figure 10.77: MSI and MSI-x Interrupts

10.23.4 AHCI PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 10.78 for AHCI PCIe SSD Device Configuration.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 10.78).

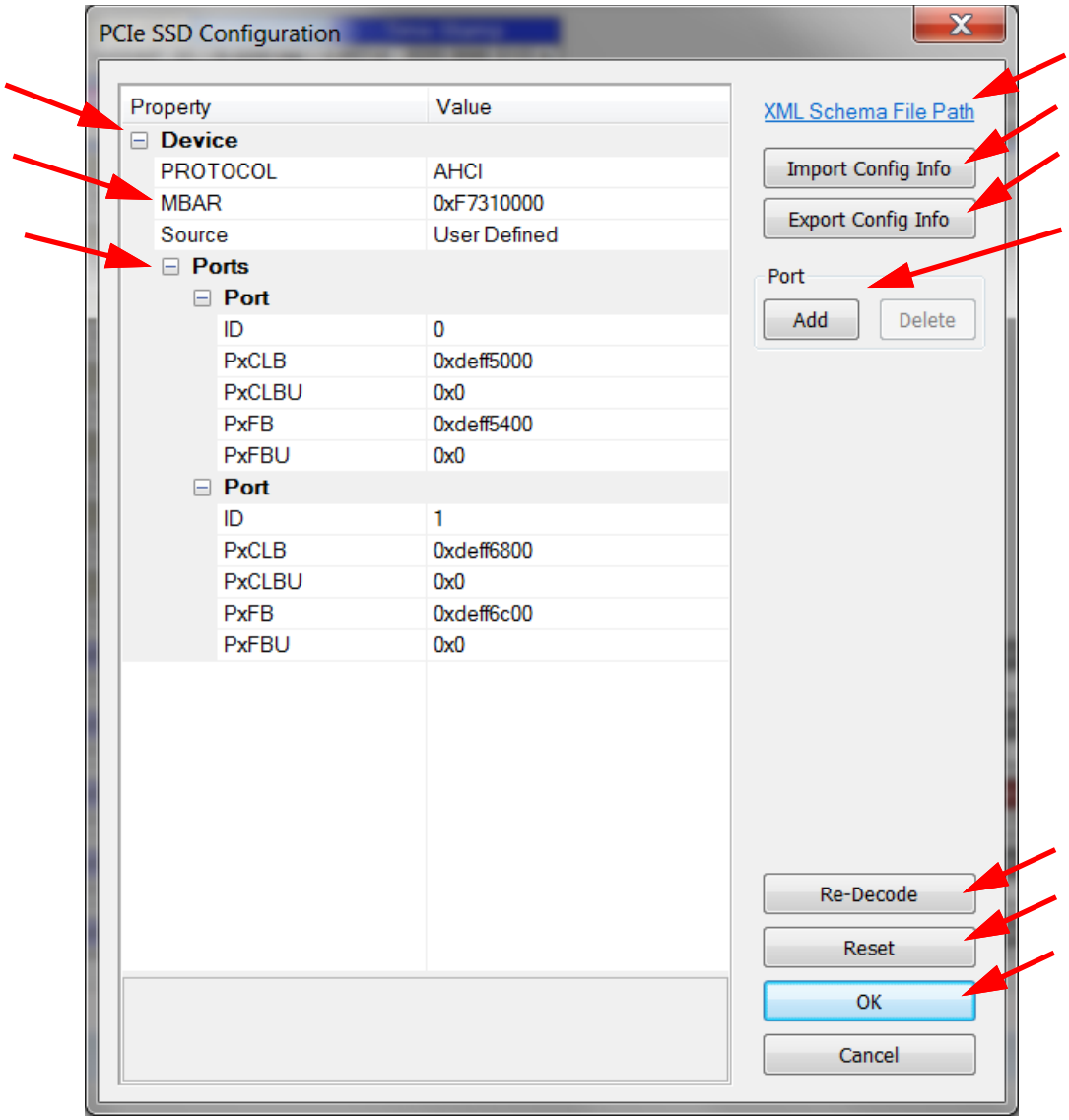


Figure 10.78: AHCI PCIe SSD Configuration Dialog

The MBAR field in this dialog is required and editable. Make sure that the information entered is correct. Click on any field and the description displays in the bottom read-only box (see Figure 10.80 on page 706). Some important fields are described below:

- Device: There is only one device node, (support for multiple device trace decoding will be available in a later release).
- MBAR: The 64-bit main address bar (i.e. BAR1:BAR0). Without this value decoding cannot be done. It should be in "0x" hex format.
- Ports: Under this node the user can add more missing nodes to decode the current trace. Click the **Add Port** or **Delete Port** button to add or delete a port node. Enter CLB, CLBU and FB, FBU address fields. The address is 32 bit and should be in "0x" hex format. Please use the right value for size as it is an important attribute. Consult the AHCI specifications for the correct value.

Clicking the **Re-Decode** button erases the current configuration from this dialog box and attempts to re-decode based on the information present in the open trace and/or saved on the disk with the last decode.

Click the **Import Config Info** button to import the configuration information as an .xml file, instead of adding it individually. Click the hyper-link **XML Schema File Path** to access the required format to generate the .xml file. This schema provides the detailed format for the imported file. All modern languages are equipped to generate an .xml file on a specific xml schema. The driver software accepts this schema and generates the .xml file with all the required information.

Click the **Export Config Info** button to export the configuration information as an .xml file.

Click the **Reset** button to reset the values to the original values. Press the **OK** button to save all the values.

10.23.5 PQI PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 10.79 for PQI PCIe SSD Device Configuration.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 10.79).

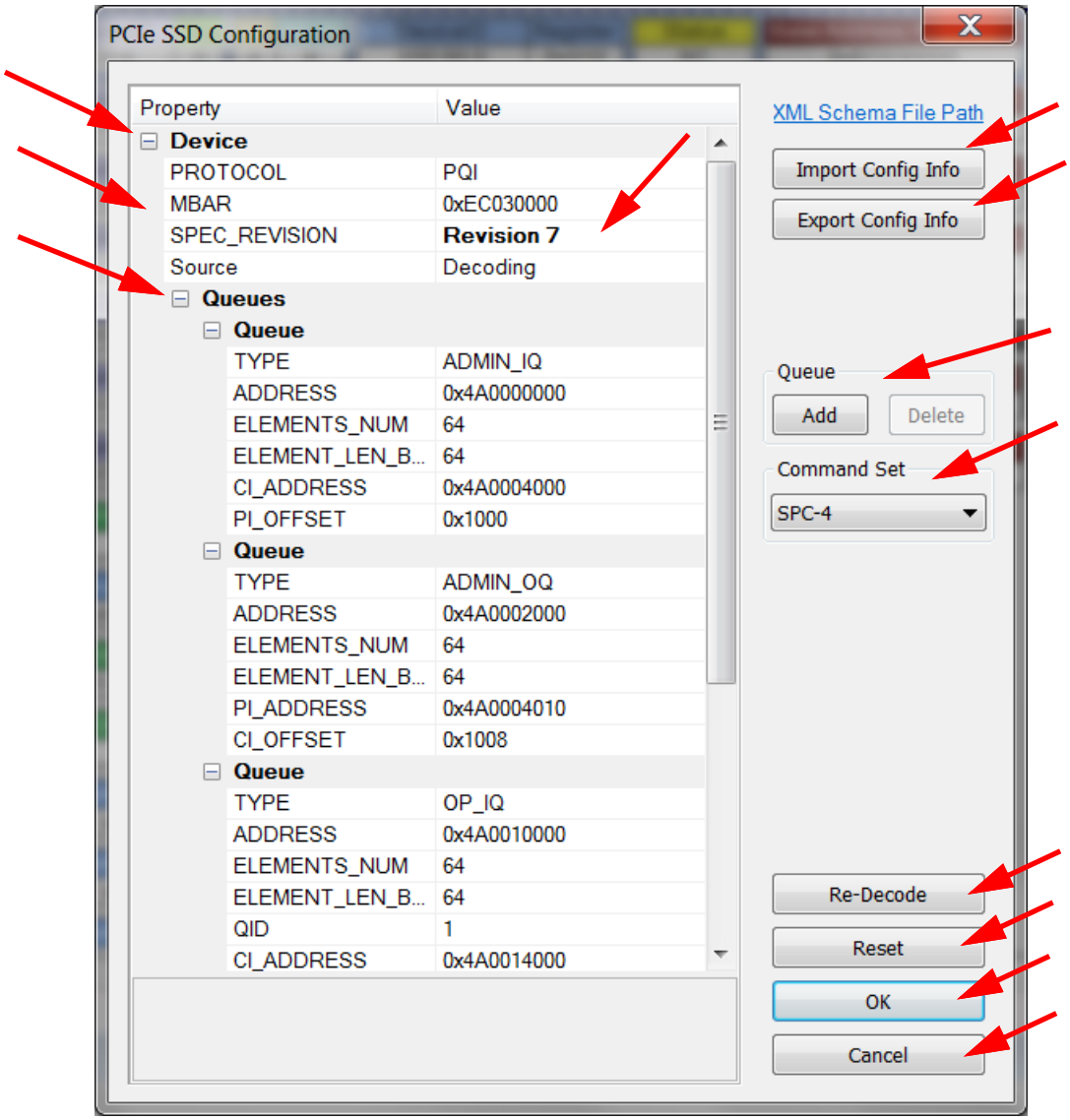


Figure 10.79: PQI PCIe SSD Configuration Dialog Pre-decoding

All the fields in this dialog are required and editable. Make sure that the information entered is correct. Click on any field and the description displays in the bottom read-only box (see Figure 10.80). Some important fields are described below:

- **Device**: There is only one device node, (support for multiple device trace decoding will be available in a later release). You can choose the spec revision from the drop down list.
- **MBAR**: The 64-bit main address bar (i.e. BAR1:BAR0). Without this value decoding cannot be done. It should be in "0x" hex format.
- **Queues**: Under this node the user can add more missing nodes to decode the current trace. Click the Add Queue or Delete Queue button to add or delete a queue node. Type based on the user selection. The following Node types are known.

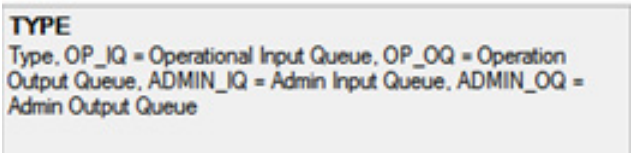


Figure 10.80: Node Types

The address is 64-bit and should be in "0x" hex format. Please use the right value for each size as it is an important attribute. Consult the NVMe specifications for the correct value. Clicking the **Re-Decode** button erases the current configuration from this dialog box and attempts to re-decode based on the information present in the open trace and/or saved on the disk with the last decode.

Click 

button to decode the trace and select **Tools > PCIe SSD Base Address Mapping** (see Figure 10.79 on page 705).

The two figures figure below show the BAR information for PQI and AHCI. If this information is present in the trace then it is not editable, otherwise it can be edited. Decoding is done only when configuration space and administration information is available.

Note: Only one device should be marked with the appropriate BAR, multiple BARs do not work.

10.23.6 SCSI PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 10.81 on page 707 for SCSI PCIe SSD Device Configuration. The base is the same as PQI Device Configuration but you can additionally choose the SCSI Command Set.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 10.81 on page 707).

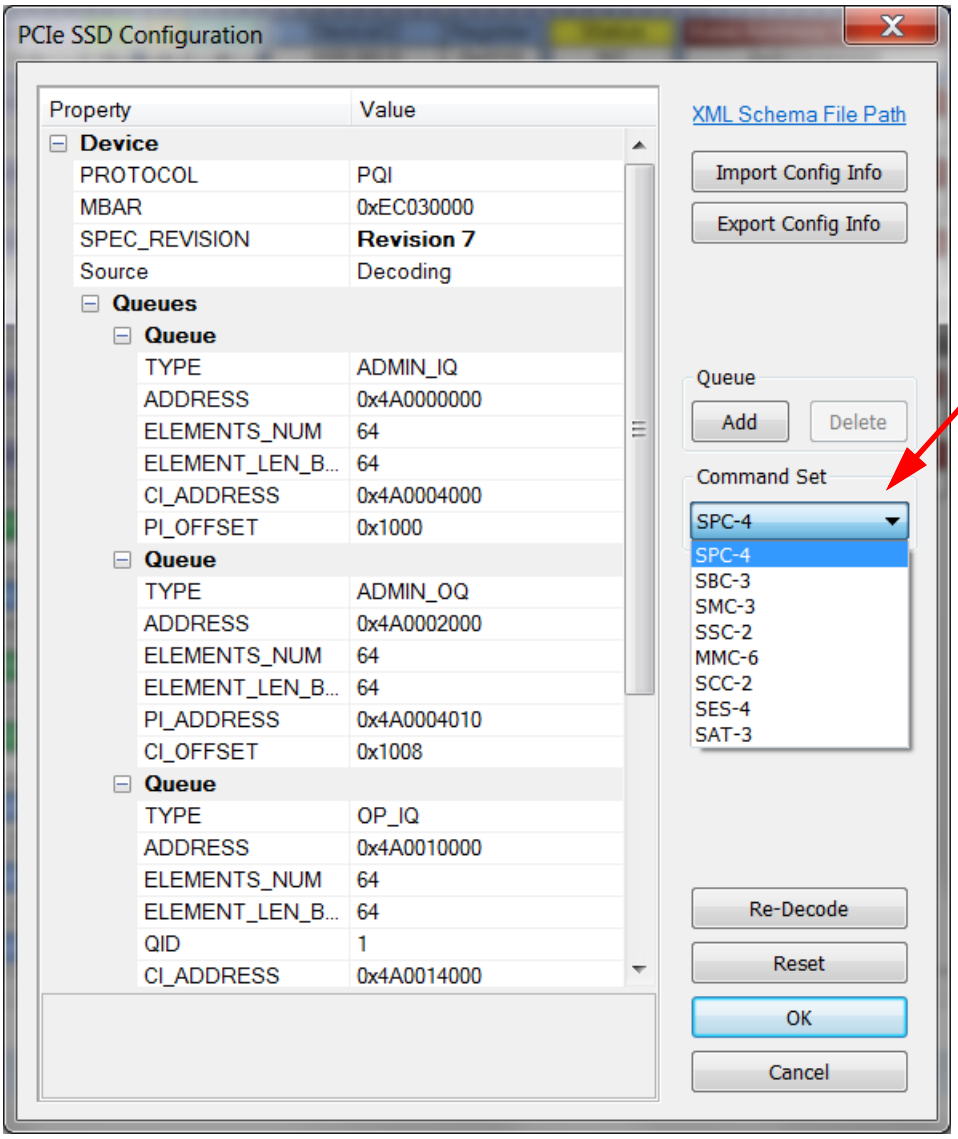


Figure 10.81: PCIe SSD Configuration Dialog - SCSI

See “Example of XML File Format for SSD Decodes” on page 735 for a template of the XML files.

10.24 Running Verification Scripts

You can run verification scripts to check errors, link transactions, split transactions, metrics, ordered sets, replays, DLLPs, and TLPs.

To display the Verification Script dialog (see Figure 10.82 on page 708), select **Tools > Run verification scripts**

or click the  icon.

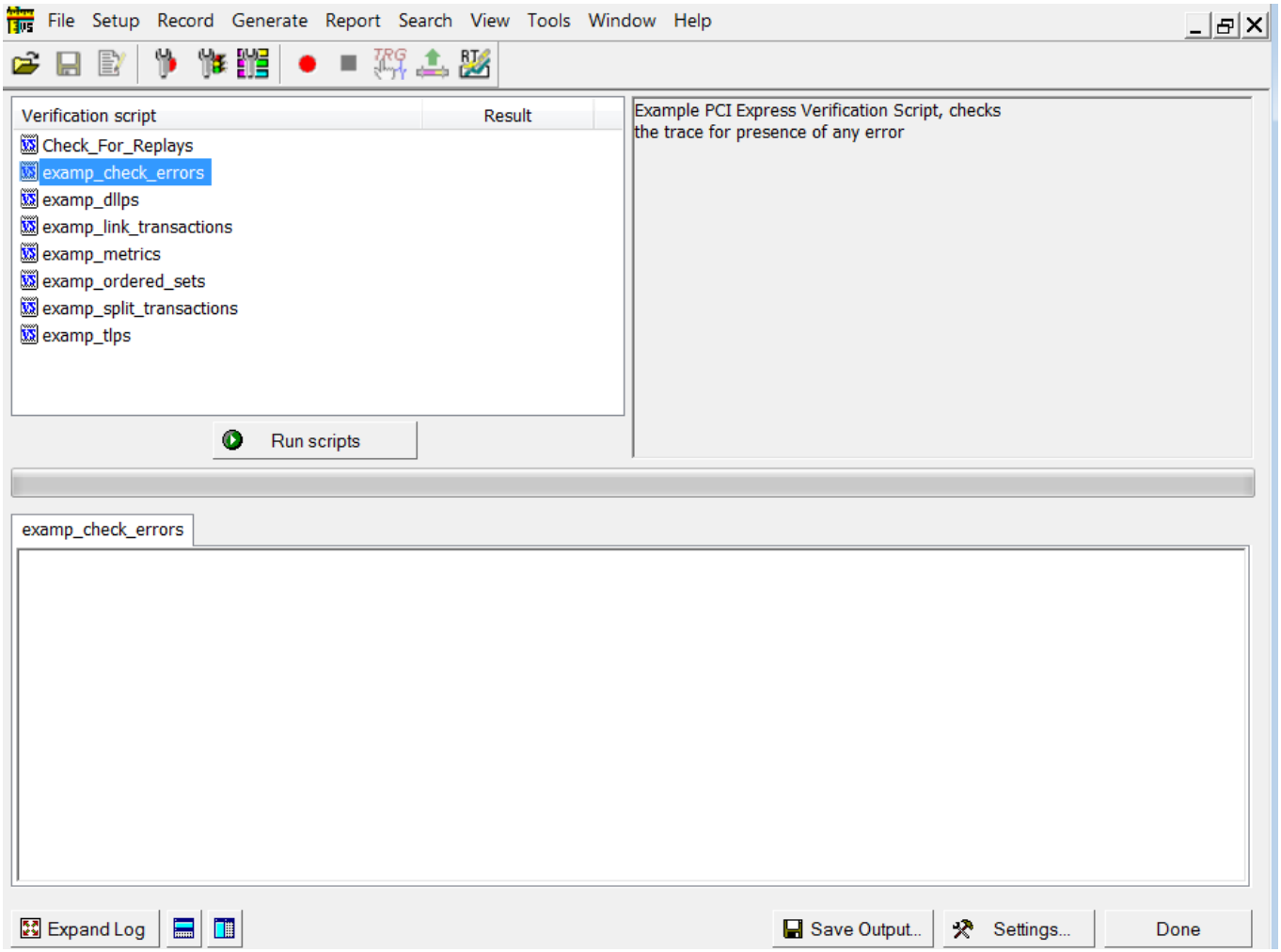


Figure 10.82: Verification Scripts Dialog

If you select examp_ltssm you'll get the following output. See Figure 10.83.

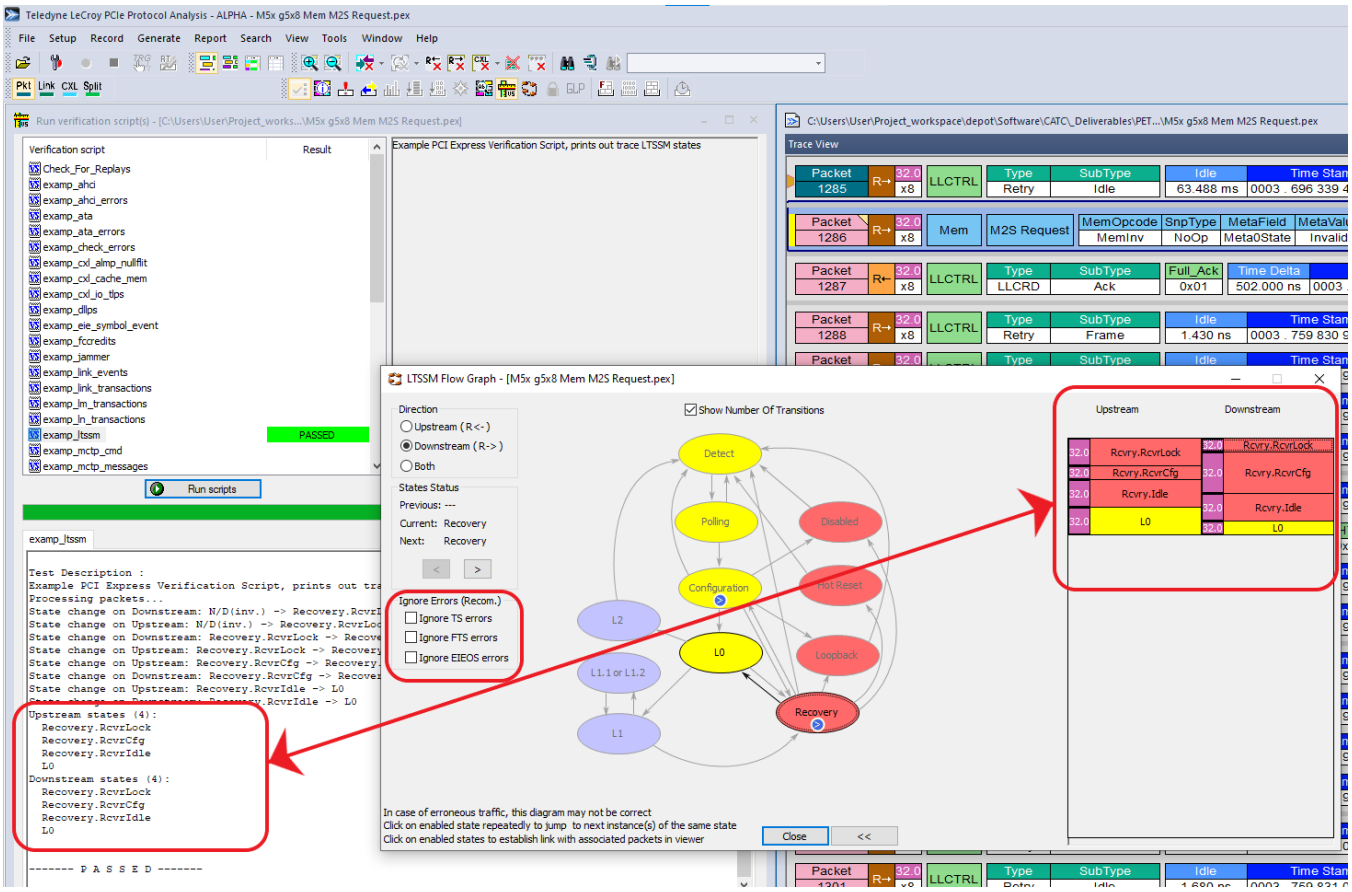
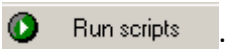


Figure 10.83: Run Verification Script: examp_ltssm

The available verification scripts are in the Verification script section.

Note: Verification scripts do not ignore TS/FTS/EIEOS errors, so values may be different if some of the Ignore options are enabled.

To run a script, select it, then click the **Run Scripts** button 

.

The results appear in the bottom window. You can expand or collapse this window. You find a view related to the CATC Trace and place this window under or to the right of it. Click **Save** to save the results.

Click the **Settings** button to display the Settings Dialog (see Figure 10.84 on page 710).

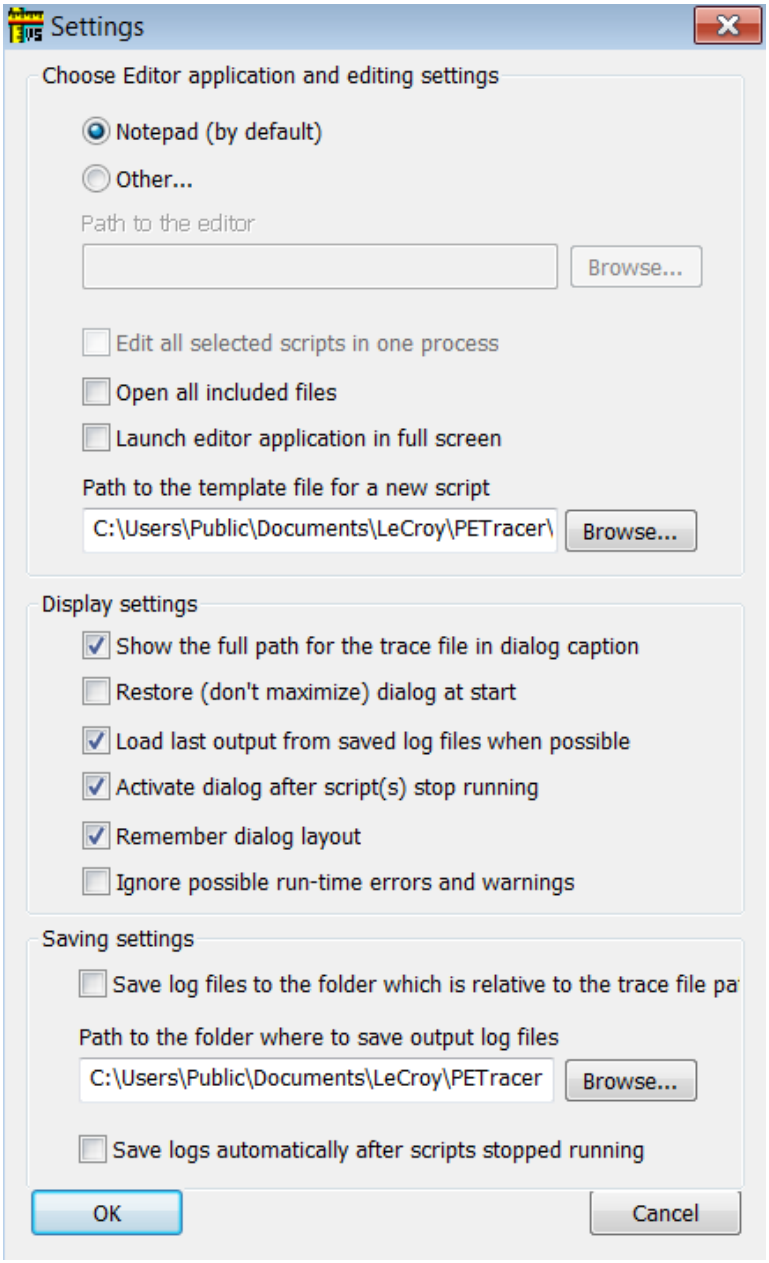


Figure 10.84: Settings Dialog

You can choose the editor, display settings, and saving settings.

10.24.1 NVMe Performance: Doorbell Timing

You can run verification scripts to determine Doorbell performance, see Figure 10.85.

The Doorbell statistics include:

- SQdoorbell to CQdoorbell,
  (time from Submission Doorbell to Completion Doorbell)
- SQDoorbell to CQentry,
  (time from SQ doorbell to command completion)
- SQentry to CQentry,
  (time from submission command to command completion

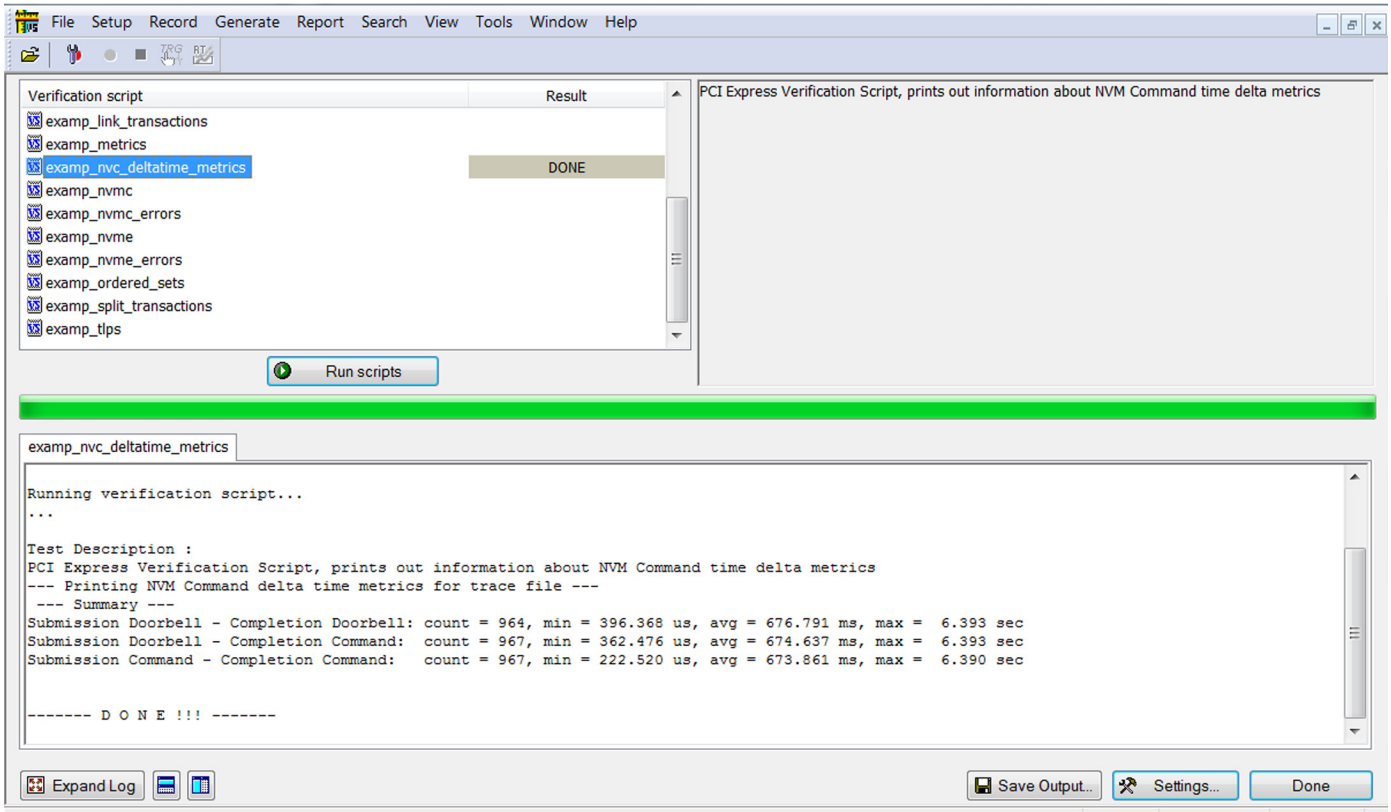


Figure 10.85: NVMe Performance Script Verification

10.24.2 MCTP Transaction Verification Script Generation

You can run the Verification Script Engine on MCTP Transactions. See Figure 10.86

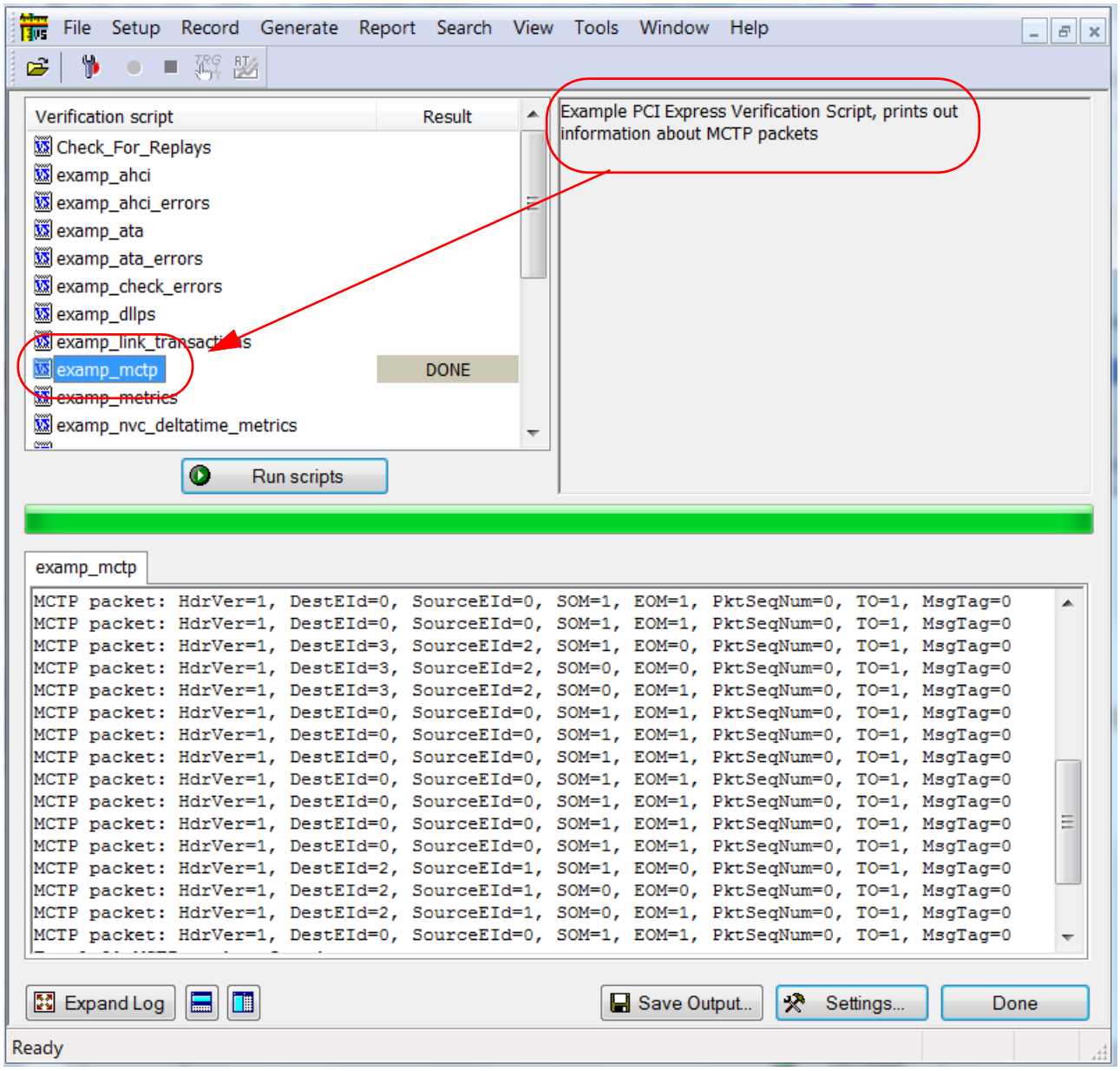


Figure 10.86: Running VSE on MCTP Transactions

10.25 Trace Expert

Trace Expert is a reporting tool that is used to create a portable, customized summary and report of a PCI express trace. The generated report groups the selected data and statistics into four groups:

- Performance Analysis
- Trace Analysis Statistics
- Error Reports
- Trace File Information

After a Trace has been loaded, Trace Expert is available from the Main Toolbar as shown in Figure 10.87.



Figure 10.87: Main Toolbar: Trace Expert

To launch the Trace Expert dialog click on the icon. Different report sections can be selected for inclusion into the final report using the dialog. The path where the report will be generated can be set at the bottom of the dialog (see Figure 10.88 on page 714). Any additional decoding required to generate the report will be done automatically.

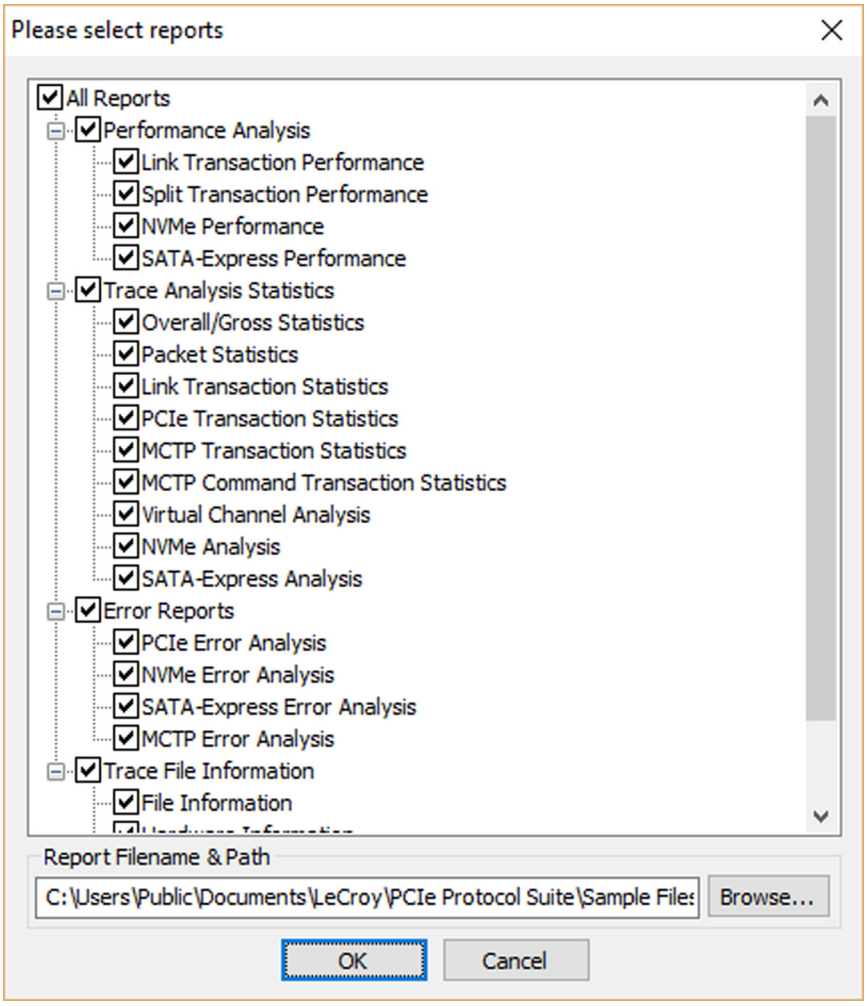


Figure 10.88: Trace Expert Report Types and Path

The generated report (see Figure 10.89 on page 715) has sections which can be expanded to show the associated data. The generated file is self-contained and portable so it can be safely emailed or archived. It will open automatically in the default browser once it is successfully generated. Icons on the top right can be used to:

- Save All (Saves to User's Download folder)
- Expand All
- Collapse All
- Print All of the currently displayed view.

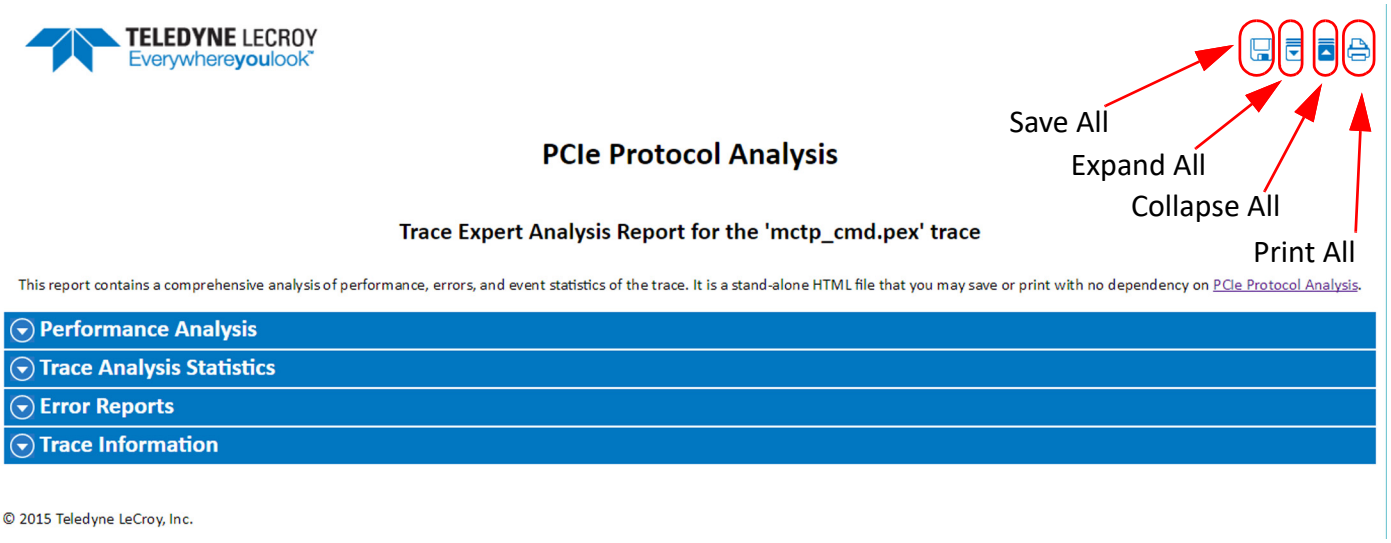


Figure 10.89: Trace Expert Main Menu

Select “Performance Analysis” on page 716 to bring up the respective dialog.

Select “Trace Analysis Statistics” on page 717 to bring up the respective dialog.

Select “Error Reports” on page 718 to bring up the respective dialog.

Select “Trace Information” on page 719 to bring up the respective dialog.

10.25.1 Performance Analysis

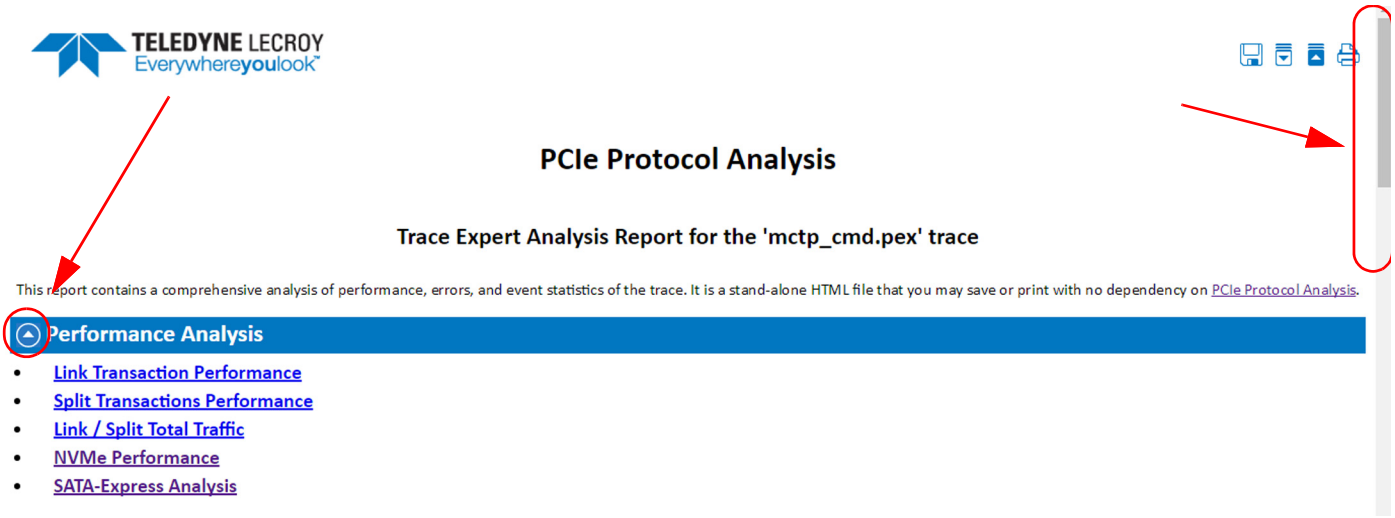


Figure 10.90: Trace Expert - Performance Analysis

You can select other types of transactions to see the other reports.

- Link Transaction Performance
- Split Transaction Performance
- Link / Split Total Traffic
- NVMe Performance
- SATA-Express Analysis

Scroll down to see the other reports and information.

10.25.2 Trace Analysis Statistics

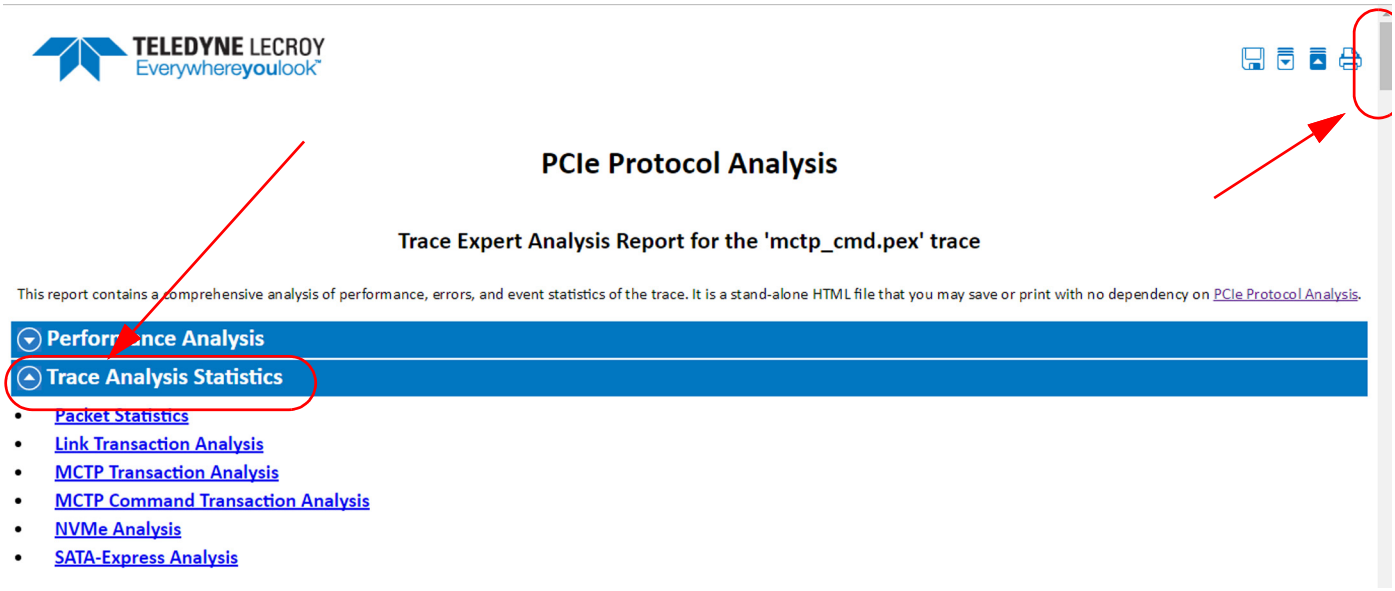


Figure 10.91: Trace Analysis Statistics

Selecting Trace Analysis Statistics will produce the following reports:

- Packet Statistics
- Link Transaction Analysis
- MCTP Transaction Analysis
- MCTP Command Transaction Analysis
- NVMe Analysis
- SATA-Express Analysis

Scroll down to see the other reports and information.

10.25.3 Error Reports

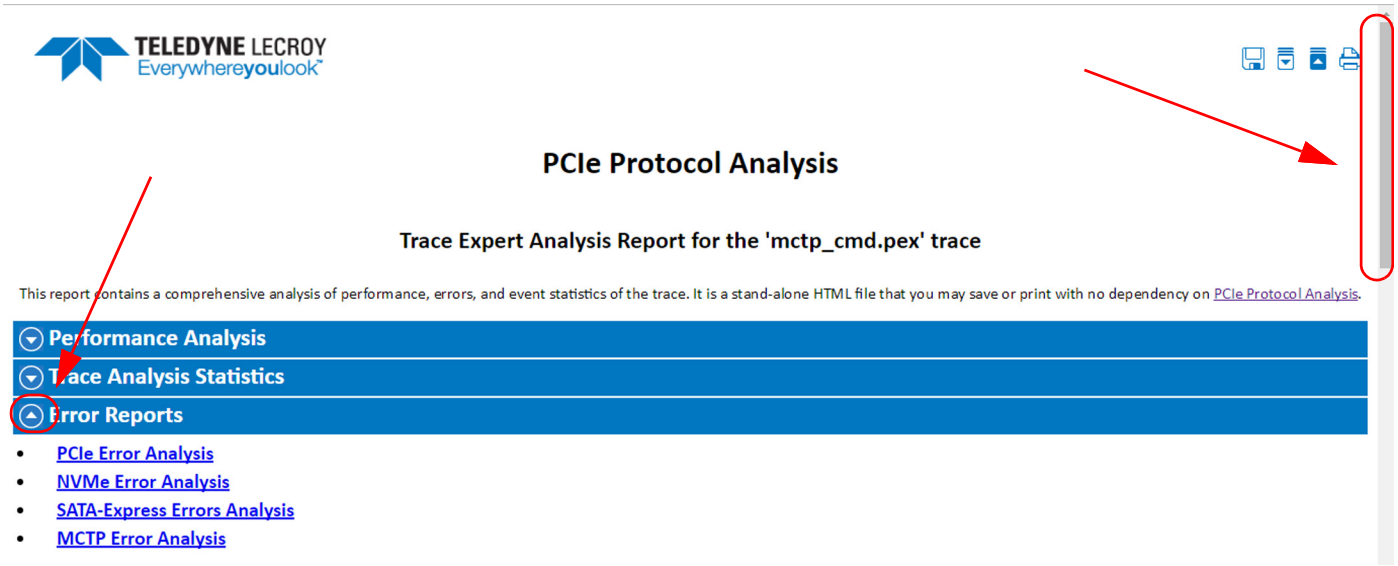


Figure 10.92: Error Reports

Selecting Error Reports generates the following reports:

- PCIe Error Analysis
- NVMe Error Analysis
- SATA-Express Errors Analysis
- MCTP Error Analysis

Scroll down to see the other reports and information.

10.25.4 Trace Information

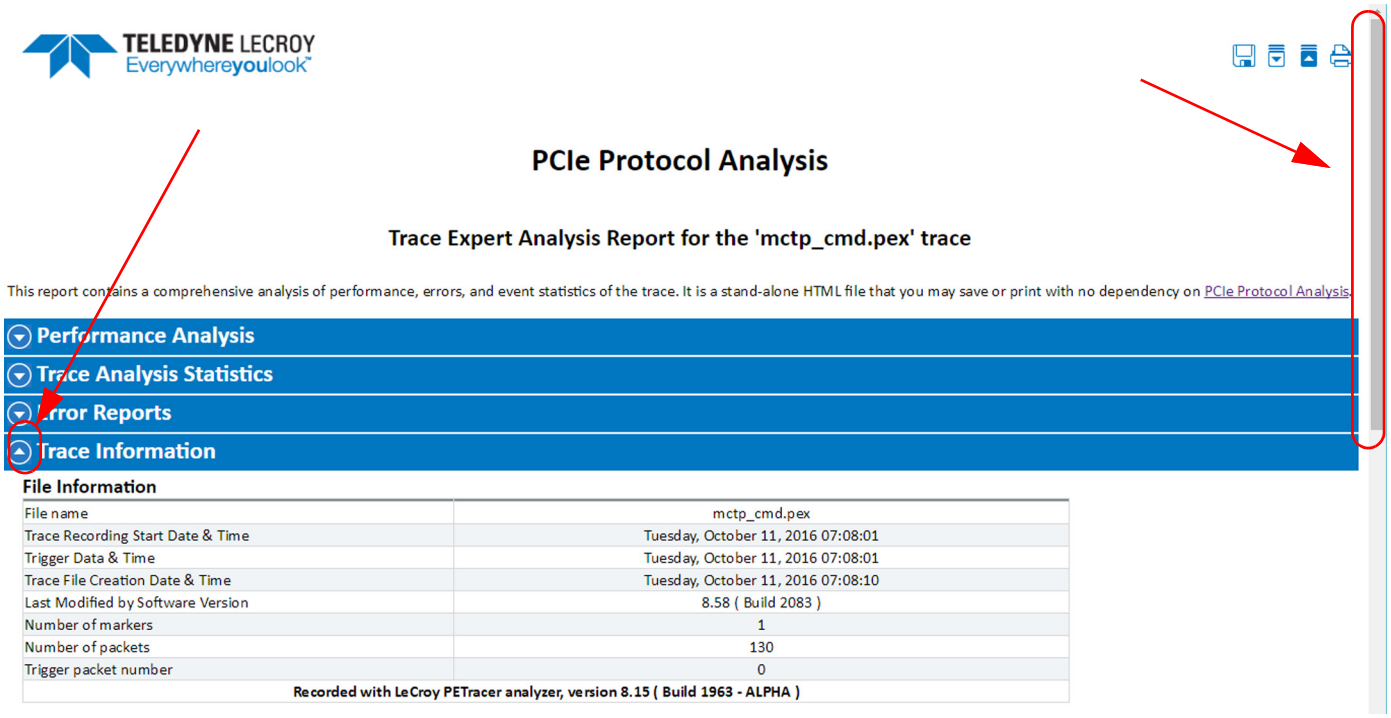


Figure 10.93: Trace Information

Selecting Trace Information generates the following reports:

- File Information
- Hardware Information
- Recording Options
- License Information

Scroll down to see the other reports and information.

Chapter 11

Updates and Licensing

11.1 Updating the Analyzer

BusEngine™ and/or Firmware updates are now automatic processes that run anytime a new version of the PCIe Protocol Analysis™ is installed that is incompatible with the currently installed BusEngine or Firmware. The update process generates on screen instructions.

If, however, you need to manually perform BusEngine or Firmware updates, follow these steps:

1. Select **Setup > Update Device** … from the menu to display the Update Analyzer dialog box for **Summit T3-16™** or other Summit Analyzer you are working with.
2. Select the appropriate file locations for the Firmware and/or BusEngine, using Browse, if necessary.
3. Check the appropriate options (if in doubt, check all options).
4. Click **Update** to initiate the updating of the Analyzer.

11.2 License Keys

A License Key is necessary to enable software maintenance. If you attempt to record with the Analyzer without an installed License Key, a message appears to indicate that a License Key is necessary in order to record traffic.

A License Key must be obtained from Teledyne LeCroy for each Analyzer.

After you obtain the License Key, follow these steps to install it:

1. Select **Setup > All Connected Devices > Update License** from the menu bar. to display the Select License Key File dialog box.
2. Enter the **path** and **filename** for the License Key or use the Browse button to navigate to the directory that contains the License Key.
3. Select the **.lic** file, and then click **Update Device**.

11.3 License Information

You can view Licensing information for your Analyzer by selecting **Help > Display License Information**… from the menu bar. The License Information window displays data about the maintenance expiration and purchased features.

Appendix A

How to Contact Teledyne LeCroy

Send e-mail to Support	psgsupport@teledyne.com
Contact Support	teledynelecroy.com/support/contact
Visit Teledyne LeCroy's website	teledynelecroy.com
Tell Teledyne LeCroy	Report a problem to Teledyne LeCroy Support via e-mail by selecting **Help > Tell Teledyne LeCroy** from the application toolbar. This requires that an e-mail client be installed and configured on the host machine.

Appendix B

China Restriction of Hazardous Substances Table

The following tables are supplied in compliance with China's Restriction of Hazardous Substances (China RoHS) requirements:

	有毒有害物质和元素					
部件名称	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr^{5+})	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
PCBAs	X	O	X	X	X	X
机械硬件	O	O	X	O	O	O
金属片	O	O	X	O	O	O
塑料部件	O	O	O	O	X	X
电源	X	X	X	O	X	X
电源线	X	O	X	O	X	X
保护外壳(如有)	O	O	O	O	X	X
电缆组件(如有)	X	O	X	O	X	X
风扇(如有)	X	O	X	O	X	X
交流滤波器和熔丝组件(如有)	X	O	X	O	O	O
外部电源(如有)	X	X	X	O	X	X
探头(如有)	X	O	X	O	X	X
O: 表明该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T11363-2006 标准规定的限量要求之下。						
X: 表明该有毒有害物质至少在该部件的某一均质材料中的含量超过 SJ/T11363-2006 标准规定的限量要求。						

EFUP (对环境友好的使用时间) 使用条件：
温度：5摄氏度到40摄氏度
湿度：5% - 95%最大相对湿度 (无冷凝)
高度：最高2000米

	Toxic or Hazardous Substances and Elements					
Part Name	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr^{6+})	Polybrominated Biphenyls (PBB)	Polybrominated Diphenyl Ethers (PBDE)
PCBAs	X	O	X	X	X	X
Mechanical Hardware	O	O	X	O	O	O
Sheet Metal	O	O	X	O	O	O
Plastic Parts	O	O	O	O	X	X
Power Supply	X	X	X	O	X	X
Power Cord	X	O	X	O	X	X
Protective Case (if present)	O	O	O	O	X	X
Cable Assemblies (if present)	X	O	X	O	X	X
Fans (if present)	X	O	X	O	X	X
AC Filter/Fuse Assy (if present)	X	O	X	O	O	O
Ext Power Supply (if present)	X	X	X	O	X	X
Probes (if present)	X	O	X	O	X	X
O: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement specified in SJ/T11363-2006.						
X: Indicates that this toxic or hazardous substance contained in at least one of the homogenous materials used for this part is above the limit requirement specified in SJ/T11363-2006.						

EFUP (Environmental Friendly Use Period) Use Conditions:

Temperature	5C to 40C
Humidity	5% to 95% max RH (non-condensing)
Altitude	Up to 2000 meters

Appendix C

Quick Search Feature

C.1 Quick Search Feature: Pre-Defined Terms

The Quick Search feature allows you to either search for a pre-defined term within a loaded Trace by clicking on the down arrow  or by typing your own term into the search window  and then moving the cursor into the window and hitting the Enter key.

A complete list of pre-defined terms is shown in Table 1.

TABLE C.1: Pre-Defined Searchable Terms

TLP - Memory Read (32 bit)	Error - TLP: Payload/Length Error
TLP - Memory Read (32 bit) - Locked	Error - TLP: Length Error (not 1)
TLP - Memory Write (32 bit)	Error - TLP: TC Error (not 0)
TLP - Memory Read (64 bit)	Error - TLP: Attr Error (not 0)
TLP - Memory Read (64 bit) - Locked	Error - TLP: AT Error (not 0)
TLP - Memory Write (64 bit)	Error - TLP: Byte Enables Violation
TLP - I/O Read Request	Error - Memory TLP: Address/Length Crosses 4K
TLP - I/O Write Request	Error - Mem64 TLP: Used Incorrectly
TLP - Configuration Read Type 0	Error - Cfg TLP: Register Error
TLP - Configuration Write Type 0	Error - Msg TLP: Invalid Routing
TLP - Configuration Read Type 1	Error - Msg TLP: Invalid Function Number field
TLP - Configuration Write Type 1	Error - Gen3 TLP: Bad Len CRC/Parity
TLP - Message	Error - Invalid Packet
TLP - Message with Data	Error - FC: Invalid Advertisement
TLP - Message for Advanced Switching	Error - FC: Insufficient Credits
TLP - Message for Advanced Switching with Data	Error - Training Sequence Format Error
TLP - Completion	Error - Training Sequence Parity Error
TLP - Completion with Data	Error - RRAP Command Aborted Error

TLP - Completion for Locked Memory Read	Error - RRAP Packet Parity Error
TLP - Completion for Locked Memory Read with Data	Error - RRAP Packet Reserved Fields Not Nullified Error
TLP - AtomicOp Fetch and Add (32 bit)	Controller Register - CAP
TLP - AtomicOp Fetch and Add (64 bit)	Controller Register - VS
TLP - AtomicOp Unconditional Swap (32 bit)	Controller Register - INTMS
TLP - AtomicOp Unconditional Swap (64 bit)	Controller Register - INTMC
TLP - AtomicOp Compare and Swap (32 bit)	Controller Register - CC
DLLP - Ack	Controller Register - Reserved
DLLP - Nak	Controller Register - CSTS
DLLP - PM	Controller Register - NSSR
DLLP - Vendor	Controller Register - AQA
DLLP - InitFC1-P	Controller Register - ASQ
DLLP - InitFC1-NP	Controller Register - ACQ
DLLP - InitFC1-Cpl	Controller Register - CMBLOC
DLLP - UpdateFC-P	Controller Register - CMBSZ
DLLP - UpdateFC-NP	Controller Register - Reserved
DLLP - UpdateFC-Cpl	Controller Register - Reserved Command Set Specific
DLLP - MRIOV	NVMe I/O Cmd - Flush
DLLP - InitFC2-P	NVMe I/O Cmd - Write
DLLP - InitFC2-NP	NVMe I/O Cmd - Read
DLLP - InitFC2-Cpl	NVMe I/O Cmd - Write Uncorrectable
DLLP - NOP	NVMe I/O Cmd - Compare
Link Events - Link Up	NVMe I/O Cmd - Write Zeroes
Link Events - Link Down	NVMe I/O Cmd - Dataset Management
Link Events - PERST# Deasserted	NVMe I/O Cmd - Reservation Register
Link Events - PERST# Asserted	NVMe I/O Cmd - Reservation Report
Link Events - WAKE# Asserted	NVMe I/O Cmd - Reservation Acquire
Link Events - WAKE# Deasserted	NVMe I/O Cmd - Reservation Release
Link Events - CLKREQ# Asserted	NVMe I/O Cmd - Vendor Specific
Link Events - CLKREQ# Deasserted	NVMe ADMIN Cmd - Delete I/O Submission Queue
Link Events - Skew	NVMe ADMIN Cmd - Create I/O Submission Queue
Error - Invalid Code	NVMe ADMIN Cmd - Get Log Page
Error - Running Disparity Error	NVMe ADMIN Cmd - Delete I/O Completion Queue

Error - Unexpected K/D Code	NVMe ADMIN Cmd - Create I/O Completion Queue
Error - Idle Data Error (not D0.0)	NVMe ADMIN Cmd - Identify
Error - Skip Late	NVMe ADMIN Cmd - Abort
Error - Skew Error	NVMe ADMIN Cmd - Set Features
Error - Bad Packet Length	NVMe ADMIN Cmd - Get Features
Error - Ordered Set Format Error	NVMe ADMIN Cmd - Asynchronous Event Request
Error - Delimiter Error	NVMe ADMIN Cmd - Firmware Activate
Error - Alignment Error	NVMe ADMIN Cmd - Firmware Image Download
Error - DLLP: Invalid Encoding	NVMe ADMIN Cmd - Format NVM
Error - DLLP: Bad CRC16	NVMe ADMIN Cmd - Security Send
Error - DLLP: Reserved Field not 0	NVMe ADMIN Cmd - Security Receive
Error - DLLP: FC Initialization Error	NVMe ADMIN Cmd - I/O Command Set specific
Error - TLP: Invalid Encoding	NVMe ADMIN Cmd - Vendor specific
Error - TLP: Bad LCRC	MCTP - Packets
Error - TLP: Bad ECRC	MCTP - Control Messages
Error - TLP: Reserved Field not 0	

Appendix D

Configuration Space Decoding

The decoded capability structures in the Configuration Space Viewer and Editor are based on programmed definitions in the PCIe Protocol Analysis and on Configuration Space Decode Scripts.

Configuration Space Decode Scripts are tools to define capability structures and instruct the Configuration Space Viewer or Editor how to decode them. These scripts are in the **\CfgSpaceScripts** sub-directory below the **\Scripts** directory in the application directory.

You can write Configuration Space Decode Scripts using the CATC Scripting Language (CSL). See the *Teledyne LeCroy Analyzers File Based Decoding Manual* for reference.

PCI Express Configuration Space Decode Scripts have the file extension **.pecfgdec**.

D.1 Mandatory Definitions

Configuration Space Decode Scripts must set the following reserved variables.

- **CapabilityName**: Name of the capability structure
- **CapabilityID**: ID of the capability structure
- **ExtAddSpace**: Set to 1 if Extended Configuration Space. Else, set to 0 for PCI.

D.2 Mandatory Module Functions

Modules are collections of functions and data dedicated to decoding a specific capability structure. Each module has one primary Configuration Space Decode Script file (extension **.pecfgdec**) and optionally has include files (**.inc**).

A module function is an entry-point into a decoding module. To help display a capability structure, the application calls a module function.

The Configuration Space Editor and Viewer support only the **DecodeRegister(offset)** and **GetSize( )** functions.

D.2.1 DecodeRegister(offset)

The application calls this function while decoding a specific DWORD offset of the specified CapabilityID. The offset is the decoding entry point, where the decoding path starts.

The Configuration Space Editor calls this function to determine how to decode the assigned configuration space. The **offset** parameter is the DWORD to decode.
An offset of 0 indicates bytes 00h-03h, an offset of 1 indicates bytes 04h-07h, and so on.

Note: The Configuration Space Editor can only decode one DWORD at a time.

D.2.2 GetSize()

This function returns the size of the capability structure specified by CapabilityID.

D.3 Configuration Register Types

The following reserved variables are defined global constants.

- CFGREG_UNDEFINED
- CFGREG_HWINIT
- CFGREG_RO
- CFGREG_RW
- CFGREG_RW1C
- CFGREG_ROS
- CFGREG_RWS
- CFGREG_RW1CS
- CFGREG_RSVDP
- CFGREG_RSVDZ

Note: These reserved variables match the Configuration Register Types of Table 7-2 in Section 7.4 of the PCI Express Base Specification, Rev. 2.1.

D.4 Primitives

Decoding uses the following primitives.

D.4.1 GetRegisterField

GetRegisterField(dword_offset, bit_offset, field_length)

This function returns a register field of length **field_length**, starting at bit position **bit_offset** in DWORD **dword_offset**.

- **dword_offset**: DWORD offset of the register field location
- **bit_offset**: Bit offset of the register field location
- **field_length**: Length of the register field

For example, **GetRegisterField(1, 9, 2);** means: Go to DWORD 1, bit offset 9, and returns 2 bits.

D.4.2 AddField

AddField(field_name, field_length, configuration_reg_type, tooltip, encoding_table = NULL)

This function adds a register field to the Capability View and returns a pointer to the field, for adding subfields.

- **field_name**: Name of the register field to display in the Capability View
- **field_length**: Length of the register field
- **configuration_reg_type**: Configuration register type of the register field. Note: If subfields are defined, their configuration register types override this setting for their specified bits.
- **tooltip**: Tooltip displayed for the register field in the Capability View
- **encoding_table**: Optional. Displays encodings as lists for select values.
- For example, user input becomes a combo box for the field in the Field View.

As examples:
AddField("PCI Express Extended Capability ID", 16, CFGREG_RO, "");
means: Add the field “PCI Express Extended Capability ID” with length 16 and cfg register type CFGREG_RO.

capability_reg = AddField(“Capability Register”, 32, CFGREG_RW, “”);
means: Added the field “Capability Register” with length 32 and cfg register type CFGREG_RW and stored a pointer to this field in variable capability_reg, which can be used to add subfields to this field.

D.4.3 AddSubField

AddSubField(parent_field, subfield_name, subfield_length, configuration_reg_type, tooltip, encoding_table = NULL);

This function adds a subfield to a register field in the Capability View. Subfields are modifiable and visible in the Field View and appear in the tooltips of register fields.

- **parent_field**: Pointer to a register field in the Capability View

- **subfield_name**: Name of the subfield, displayed in the Field View
- **subfield_length**: Length of the subfield
- **configuration_reg_type**: Configuration register type of the subfield field. Note: This overrides the configuration_reg_type of the parent field.
- **tooltip**: Tooltip displayed for the subfield in the Capability View
- **encoding_table**: Optional. Displays encodings as lists for select values.
- For example, user input becomes a combo box for the field in the Field View.

For example,
AddSubField(capability_reg, "Mode Supported", 4, CFGREG_RO, "Indicates the Function modes,"), ModeEncodings);
means: Add the subfield "Mode Supported" to the parent field "capability_reg" with length 4, type CFGREG_RO, a tooltip in the Capability View, and a combo box displaying "mode encodings" for input in the Field View.

D.5 Helper File

ConfigSpaceCommon.inc include file contains useful functions for script decoding.

Appendix E

Example of XML File Format for SSD Decodes

```
<DEVICES XML_FORMAT_VERSION="1.0">
<DEVICE ENABLE="0x1" VENDORID="0" CLASSCODE="67586" GUID="{9C9654A1-B693-4F30-912F-125059814C42}"
  DEVICEID="000:00:0">
<BARS>
<MBAR ID="0" VALUE="0xF0000000"/>
<BAR ID="2" VALUE="0x00000000"/>
<BAR ID="3" VALUE="0x00000000"/>
<BAR ID="4" VALUE="0x00000000"/>
<BAR ID="5" VALUE="0x00000000"/>
</BARS>
<PROTOCOL ASQS="64" DSTRD="4" ACQS="16" LBASIZE="512" PROTOCOL="NVME" MPS="4096"
  ADDEDBY="DECODING"/>
<Queues>
<Queue SIZE="10" QID="2" TYPE="IOSQ" ADDRESS="0x11B210300" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="3" TYPE="IOSQ" ADDRESS="0x11B210340" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="5" TYPE="IOSQ" ADDRESS="0x11B210380" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="7" TYPE="IOSQ" ADDRESS="0x11B2103C0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="9" TYPE="IOSQ" ADDRESS="0x11B210400" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="11" TYPE="IOSQ" ADDRESS="0x11B210E80" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="14" TYPE="IOSQ" ADDRESS="0x11B210E40" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="16" TYPE="IOSQ" ADDRESS="0x11B210E00" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="6" TYPE="IOSQ" ADDRESS="0x11B233040" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="8" TYPE="IOSQ" ADDRESS="0x11B233080" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="10" TYPE="IOSQ" ADDRESS="0x11B233B40" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="12" TYPE="IOSQ" ADDRESS="0x11B233B00" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="13" TYPE="IOSQ" ADDRESS="0x11B233AC0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="15" TYPE="IOSQ" ADDRESS="0x11B233A80" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="17" TYPE="IOSQ" ADDRESS="0x11B233A40" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="1" TYPE="IOSQ" ADDRESS="0x11B25F080" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="4" TYPE="IOSQ" ADDRESS="0x11B28B040" ADDEDBY="DECODING"/>
```

<Queue SIZE="10" QID="3" TYPE="IOCQ" ADDRESS="0x11B2200C0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="5" TYPE="IOCQ" ADDRESS="0x11B2200E0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="7" TYPE="IOCQ" ADDRESS="0x11B2200F0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="9" TYPE="IOCQ" ADDRESS="0x11B220100" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="11" TYPE="IOCQ" ADDRESS="0x11B2203A0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="14" TYPE="IOCQ" ADDRESS="0x11B220390" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="16" TYPE="IOCQ" ADDRESS="0x11B220380" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="6" TYPE="IOCQ" ADDRESS="0x11B243010" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="8" TYPE="IOCQ" ADDRESS="0x11B243020" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="10" TYPE="IOCQ" ADDRESS="0x11B2432D0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="12" TYPE="IOCQ" ADDRESS="0x11B2432C0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="13" TYPE="IOCQ" ADDRESS="0x11B2432B0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="15" TYPE="IOCQ" ADDRESS="0x11B2432A0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="16" TYPE="IOCQ" ADDRESS="0x11B243290" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="1" TYPE="IOCQ" ADDRESS="0x11B26F020" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="2" TYPE="IOCQ" ADDRESS="0x11B26F030" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="4" TYPE="IOCQ" ADDRESS="0x11B29B010" ADDEDBY="DECODING"/>
</Queues>
</DEVICE>
</DEVICES>

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